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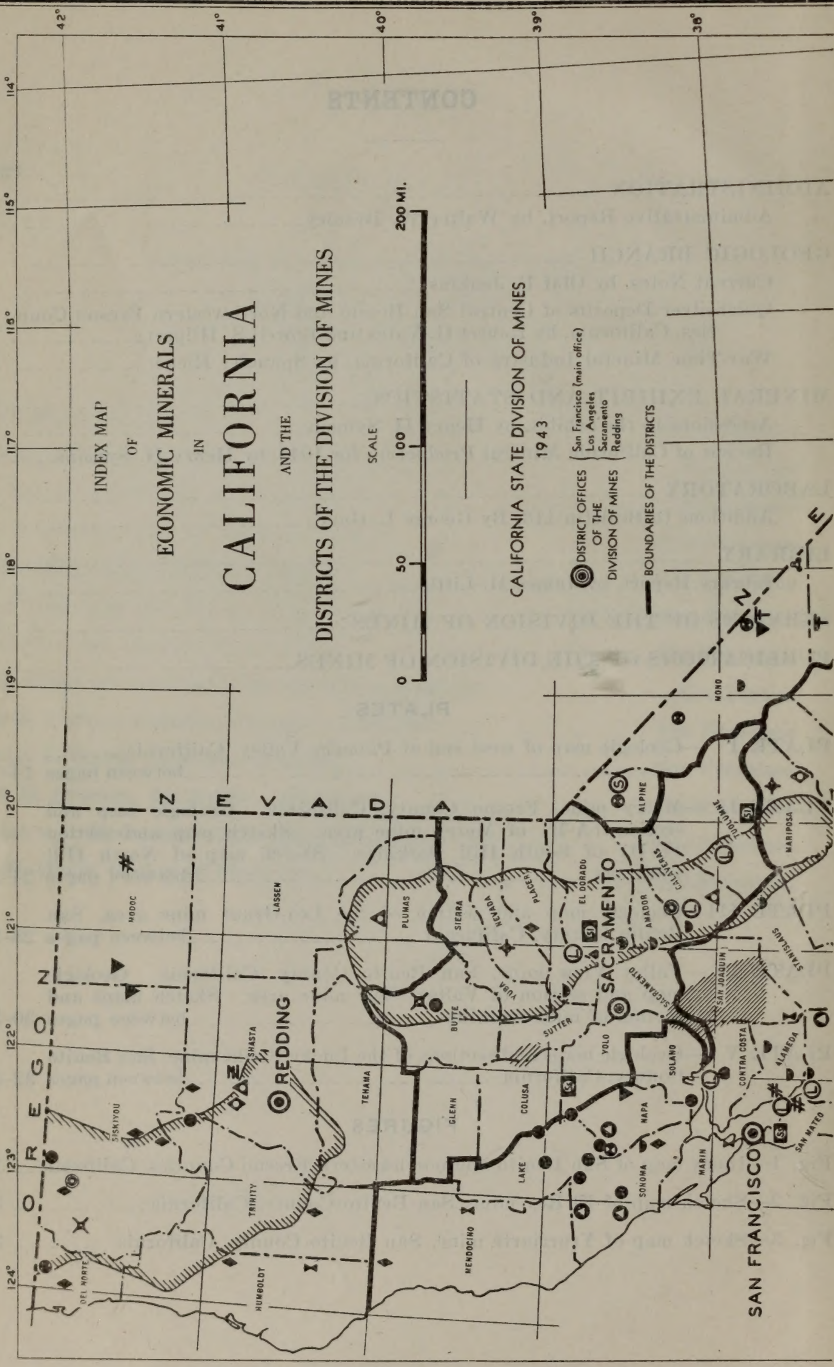
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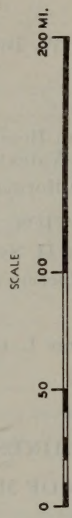
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IN
CALIFORNIA
AND THE
DISTRICTS OF THE DIVISION OF MINES



CALIFORNIA STATE DIVISION OF MINES
1943

DISTRICT OFFICES
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ECONOMIC MINERALS

FUELS

GAS DISTRICT
OIL & GAS DISTRICT

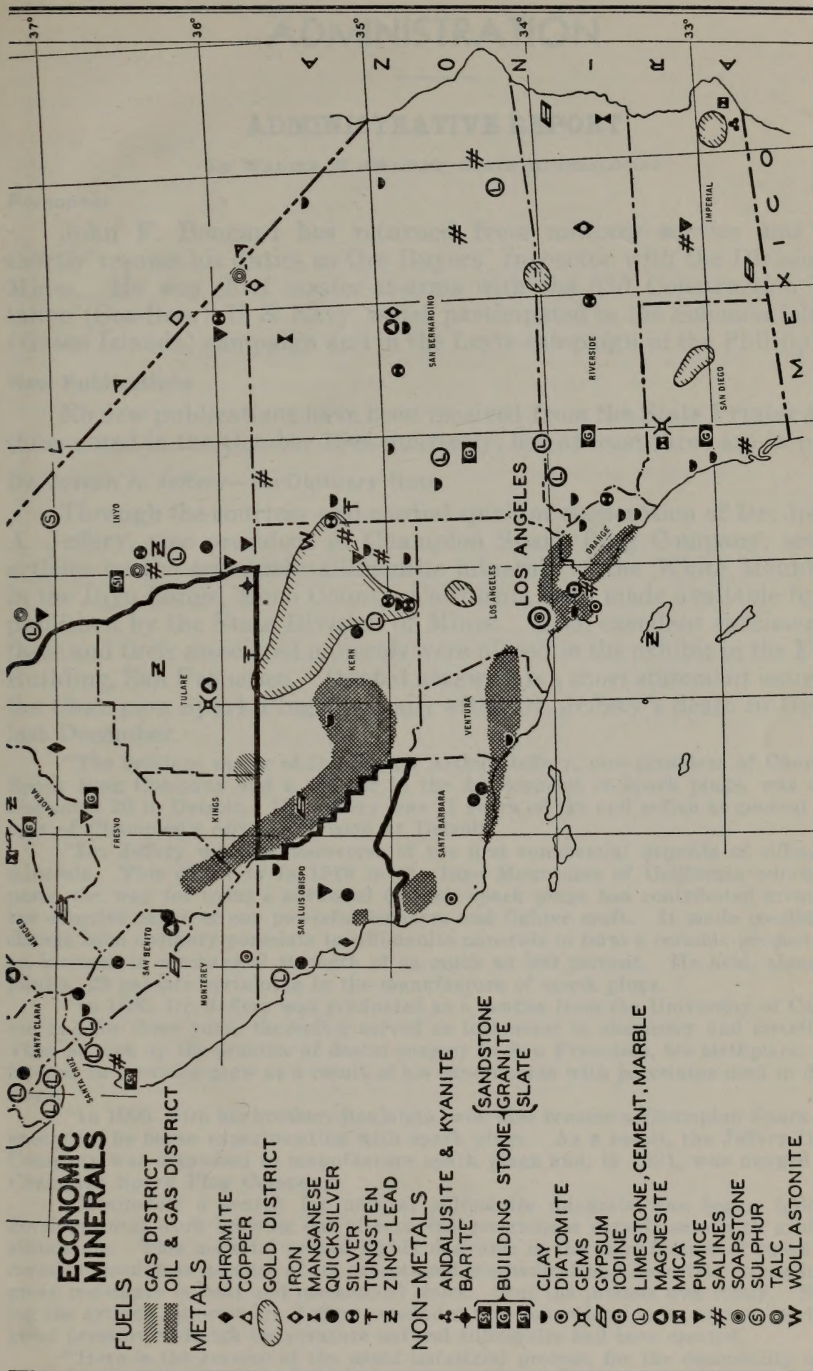
METALS

CHROMITE
COPPER
GOLD DISTRICT

IRON
MANGANESE
QUICKSILVER
SILVER
TUNGSTEN
ZINC-LEAD

NON-METALS

ANDALUSITE & KYANITE
BARITE
SANDSTONE
BUILDING STONE
GRANITE
SLATE
CLAY
DIATOMITE
GEMS
GYPSUM
IODINE
LIMESTONE, CEMENT, MARBLE
MAGNESITE
MICA
PUMICE
SALINES
SOAPSTONE
SULPHUR
TALC
WOLLASTONITE



ADMINISTRATION

ADMINISTRATIVE REPORT

By WALTER W. BRADLEY, STATE MINERALOGIST

Personnel

John F. Bongard has returned from military service and will shortly resume his duties as Ore Buyers' Inspector with the Division of Mines. He was chief master-at-arms with the 93d Construction Battalion (Sea-Bees), U. S. Navy, which participated in the Solomon Islands (Green Islands) campaign and in the Leyte campaign in the Philippines.

New Publications

No new publications have been received from the State Printer since those noted in the October 1944 quarterly, but at least three are in press.

Dr. Joseph A. Jeffery—An Obituary Note

Through the courtesy and cordial spirit of cooperation of Dr. Joseph A. Jeffery, vice president of Champion Spark Plug Company, several articles on the andalusite-sillimanite minerals of the White Mountains in the Inyo Range, Mono County, California were made available to and published by the State Division of Mines. Also, excellent specimens of these and their associated minerals were placed in the exhibit in the Ferry Building, San Francisco. Quoted herewith is a short statement issued by the Champion Spark Plug Company after Dr. Jeffery's death in Detroit last December.

"The brilliant career of Dr. Joseph Arthur Jeffery, vice president of Champion Spark Plug Company and a pioneer in the development of spark plugs, was ended December 26 in Detroit. Dr. Jeffery was 71 years of age and active as general manager of Champion's ceramic division at Detroit.

"Dr. Jeffery was the discoverer of the first commercial deposits of sillimanite minerals. This discovery in 1919 in the Inyo Mountains of California which prepared the way for today's advanced ceramic spark plugs has contributed greatly to the effective range of our powerful bombers and fighter craft. It made possible the change from ordinary porcelain to sillimanite minerals to form a ceramic product with an increase in mechanical strength of as much as 500 percent. He held, alone and jointly, 23 patents pertaining to the manufacture of spark plugs.

"In 1895, Dr. Jeffery was graduated as a dentist from the University of California and for three years thereafter served as instructor in chemistry and metallurgy. Then he took up the practice of dental surgery in San Francisco, his birthplace. His interest in ceramics grew as a result of his experiments with porcelains used in dental work.

"In 1905, with his brother, Benjamin, who also became a Champion Spark Plug executive, he began experimenting with spark plugs. As a result, the Jeffery-Dewitt Company was organized to manufacture spark plugs and, in 1921, was merged with Champion Spark Plug Company.

"Meanwhile a search for natural sillimanite minerals was begun following developmental work growing out of reported government experiments with synthetic sillimanite. This material proved highly desirable in the manufacture of spark plug cores or insulators because of its exceptional mechanical and dielectric strength, and great resistance to heat and mechanical shock. But the process was costly. Studying the artificial process Dr. Jeffery concluded that somewhere in an ancient period of great pressure and high temperature natural sillimanite had been created.

"Here is the reverse of the usual industrial process, for the desirability of the material for a product was determined before the natural material itself was known to exist in commercial quantities.

"In his unremitting quest through every available geological source Dr. Jeffery finally came upon an article in an obscure geological journal.¹ In it was a reference to the finding of sillimanite crystals in California's Inyo range. With a companion, Dr. Jeffery spent part of 1918 in exploration, finding the locality mentioned in the article but disappointed in the quantity and impurity of the scant mineral deposit there.

"The next year he continued his search and, one night in making his bed upon pine needles, encountered a crystalline rock of extremely high gravity. In the morning he identified the 'rock' as sillimanite. But the camp was at the foot of a cliff thousands of feet high. Somewhere, along the perpendicular face, was the vein of sillimanite from which the 'rock' had fallen.

"Precarious exploration of the cliff face revealed an almost solid deposit—millions of tons of the sillimanite mineral. Nowhere else in the range has this mineral since been found, and it is unlikely that the cliff ever would have been studied save for the 'rock' in Dr. Jeffery's bed.

"In the development of sillimanite extremely high firing temperatures are required and here too, Dr. Jeffery pioneered, for sillimanite itself proved unequalled as a refractory for kilns, operating at constant high temperatures. It is widely used in this specialized field and in many metallurgical processes where high temperatures are required.

"Dr. Jeffery was also president of Champion Sillimanite Inc. of California and Nevada, a subsidiary of the parent company. He was a member of the Detroit Engineering Society, American Institute of Electrical Engineers, American Ceramic Society, Electro Chemical Society, American Institute of Mining and Metallurgical Engineers, and the Detroit Athletic Club.

"He is survived by his widow, Mrs. Josephine E. Jeffery, his daughter, Mrs. C. Douglas Woodhouse of Santa Barbara, California, his brother, Benjamin, and sisters, Mrs. Chas. E. Julian and Mrs. Chas. H. Lawson. Burial was in California."

¹Knopf, Adolph, An andalusite mass in the pre-Cambrian of the Inyo Range, Cal.: Washington Acad. Sci. Jour., vol. 7, pp. 549-552 (1917).

GEOLOGIC BRANCH

CURRENT NOTES

By OLAF P. JENKINS *

In This Issue

Results of geologic investigations by the United States Geological Survey of strategic mineral deposits in California are now being published by the State Division of Mines. In this issue of the *Journal* are contributions by the Survey on some quicksilver deposits located in San Benito and Fresno Counties.

The United States Bureau of Mines has also contributed, through the efforts of Mr. Spangler Ricker, a summary report on the war-time mineral industry of the State as investigated by that Bureau.

In Press

The State Division of Mines' forthcoming Bulletin 129, *Iron Resources of California*, is to be issued first as separate chapters and finally as a bound volume. Several chapters already have been contributed by the U. S. Geological Survey, and are now in press. They are:

Bulletin 129-A, *Iron-ore deposits in the eastern part of the Eagle Mountains, Riverside County, California*, by Jarvis B. Hadley.

Bulletin 129-B, *Iron Mountain iron-ore deposits, Lava Bed district, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-C, *Iron Mountain and Iron King iron-ore deposits, Silver Lake district, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-D, *Old Dad Mountain iron-ore deposit, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-E, *Cave Canyon iron-ore deposits, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-F, *Vulcan iron-ore deposit, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-G, *Iron Hat (Ironclad) iron-ore deposits, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-H, *Ship Mountains iron-ore deposit, San Bernardino County, California*, by Carl A. Lamey.

Bulletin 129-I, *Minarets magnetite deposits of Iron Mountain, Madera County, California*, by Parker D. Trask and Frank S. Simons.

Bulletin 129-J, *Hirz Mountain iron-ore deposits, Shasta County, California*, by Carl A. Lamey.

This bulletin will also contain a series of tables, giving pertinent information concerning all known iron deposits in the State. Accompanying this tabulation will be *Economic Mineral Map of California No. 6—Iron*, showing in classified order all the deposits of iron ore. It will be issued on the State geologic base map, scale 1:1,000,000, as used for the other economic mineral maps (1 to 5, inclusive).

* Chief Geologist; California State Division of Mines. Manuscript submitted for publication June 7, 1945.

Forthcoming Publications

In a forthcoming issue of the *Journal* will appear the following strategic mineral report contributed by the U. S. Geological Survey: *Quicksilver deposits of the Knoxville district, Napa, Yolo, and Lake Counties, California*, by Paul Averitt.

Another quadrangle geologic map is soon to go to press. This is the *Geologic Map of the San Juan Bautista Quadrangle*, by John Eliot Allen. It will be accompanied by a detailed geologic report and description of the mineral deposits (including the Sargent oil field). This work represents Dr. Allen's Doctor's thesis which has recently been accepted at the University of California.

QUICKSILVER DEPOSITS OF CENTRAL SAN BENITO AND NORTHWESTERN FRESNO COUNTIES, CALIFORNIA *

By ROBERT G. YATES** AND LOWELL S. HILPERT**
UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

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* Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Manuscript submitted for publication November 1944.

** Geologist, Geological Survey, U. S. Department of the Interior.

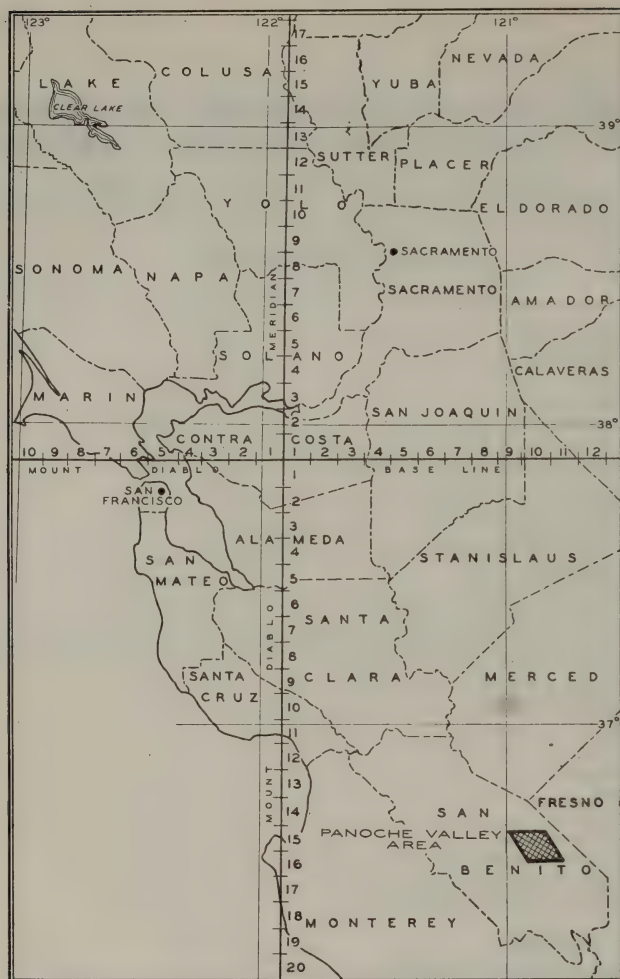


FIG. 1. Index map of San Benito and northwestern Fresno Counties, California

ABSTRACT

Most of the quicksilver deposits described in this report lie in a fairly compact group about Panoche Valley in central San Benito County, California. One mine, the Mercy, is 5 miles north of this valley in northwestern Fresno County and another, the Cerro Gordo, is about 9 miles to the west. Quicksilver was discovered in the region about 1859. Since then mining has been sporadic and the total output of quicksilver small. Discoveries since 1938 reawakened interest in the district and 1,741 flasks of quicksilver were produced between 1938 and 1944. This brought the total known production of the district to about 3,840 flasks.

The quicksilver deposits are in a part of the Diablo Range characterized by north-westward-trending folds and by faults of diverse trends. Sedimentary rocks involved in these structures range in age from Jurassic to Recent, and the movements that produced the structures were probably recurrent during that time. Intrusive and extrusive igneous rocks formed at several periods. All but two of the quicksilver deposits are in the Jurassic Franciscan formation, which is the oldest, most widespread, and most diverse group of rocks in the area. Although the quicksilver deposits are of late Tertiary age, none have been found in the Tertiary rocks, and only two have been found in the Cretaceous rocks.

The quicksilver deposits consist of irregular veins and disseminations of cinnabar or metacinnabar in silicified or kaolinized sandstone and fault breccia, and in silica-carbonate rock formed by the hydrothermal alteration of serpentine. Prominent fault zones enclose, or are near, all the deposits except one. Most of the orebodies are irregular and of little horizontal or vertical extent and their positions and forms were controlled by minor faults and fractures or by the character of the wall rock. The deposits are characteristically spotty, consequently the grade of the ore varies between wide limits. Ore reserves in the district are not amenable to measurement. It is probable, however, that a small but wavering production will be maintained as long as the price of quicksilver exceeds \$175 a flask.

Further prospecting may disclose new deposits. Their universal association with faults and zones of hydrothermally altered rocks should be a valuable guide in prospecting.

INTRODUCTION

The quicksilver deposits described in this report are in the Diablo Range, one of the California Coast Ranges. Most of the mines lie in a fairly compact group about Panoche Valley, in central San Benito County (see fig. 1), but one mine, the Cerro Gordo, is 9 miles west of this valley, and another, the Mercy, is about 5 miles north in Fresno County. This group of mines, exclusive of the Mercy mine, is referred to in former reports¹ as the Central San Benito district. In this report, for convenience in description, the Mercy mine is also included in the district.

No towns are within the area and the nearest railroad shipping points, Tres Pinos and South Dos Palos, are 30 to 40 miles from most of the mines. All the mines are within 3 miles of surface highways, and almost all are connected with these highways by graded or ungraded roads.

This part of the Diablo Range is a region of moderately rugged ridges and broad, flat, intervening valleys. Local relief ranges from 1,200 feet, the average altitude of Panoche Valley, to over 2,300 feet. Drainage in the main part of the district is eastward into the San Joaquin Valley. The Cerro Gordo mine, the only one in the district on the west side of the Diablo Range, is on Tres Pinos Creek which drains westward into Santa Clara Valley. Only the main streams persist throughout the year. Although the winter months are rainy, the rest of the year is hot and dry, particularly during the summer. The floor of Panoche Valley is covered by fields of grain and other crops; Cerro Bonito Ridge, south of the valley, is covered for the most part by dense brush and oak and pine trees. The hills north and west of the valley are barren except for grass, sparse brush, and scattered trees.

Field work was in progress from mid-May through June 1941 and was supplemented by a brief visit to the mines in December 1941 and a visit to the Lucky Strike mine in March 1944. The geology of about fifty square miles was mapped on aerial photographs obtained from the Agricultural Adjustment Administration. This geology was later transferred to the topographic map of the Panoche Valley quadrangle (see Pl. I). All surface and underground mine maps were made by the writers, with the exception of the topographic map of the Lea-Grant property, kindly furnished by the Lea-Grant Mining Syndicate.

¹Forstner, William, The quicksilver resources of California: California Min. Bur. Bull. 27, p. 125, 1903. Bradley, W. W., Quicksilver resources of California: California Min. Bur. Bull. 78, pp. 95-96, 1918. Ransome, A. L., and Kellogg, J. L., Quicksilver resources of California: California Div. Mines Rept. 35, p. 416, 1939.

No inclusive geologic study of the quicksilver deposits of the Central San Benito district has been made prior to this work. Enough published data² are available, however, to give a sketchy history of the early mining and development of the district.

The mining men of the district were uniformly courteous and helpful and their assistance is greatly appreciated. The writers are indebted to the Topographic Branch of the Geological Survey for early release of photostatic copies of plane table sheets of the topographic map of the Panoche Valley quadrangle. They are also indebted to E. B. Eckel for advice during field work and preparation of this report, and to Howel Williams and A. C. Waters who contributed many helpful suggestions.

HISTORY AND PRODUCTION

The mines in this area, although constituting one of the older California quicksilver districts, have only a small total production and a history of sporadic operation. Mining began in 1859 when the Cerro Gordo mine was discovered. Shortly thereafter, in 1860 or slightly later, the Mercy mine was discovered, and in 1874 the Cerro Bonito was opened. The Mercy is the only one of the older mines which has continued to produce, although in intermittently, up to the present. In 1938 interest in the district was revived by discovery of the Valley View mine. Since then the Lea-Grant mine and numerous other deposits have been discovered.

The Central San Benito district (including the Mercy mine) has a recorded production of 3,840 flasks of quicksilver up to 1943, inclusive. This figure would be increased somewhat if the early production from the Mercy mine were on record.

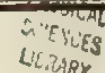
Quicksilver production, Central San Benito district, 1939-1943

<i>Year</i>	<i>Flasks</i>
1939 -----	3
1940 -----	276
1941 -----	512
1942 -----	698
1943 -----	252

GEOLOGY

Most of the mines in the Central San Benito quicksilver district are on the east side of the Diablo Range within an area that is characterized by en echelon folds trending N. 70° W. These folds are oblique to the northwest trend of the range and to the San Andreas fault, which lies a few miles west of the district. One fold, the Ciervo anticline, crosses the southern part of the area (see Pl. I). Panoche Valley, on whose slopes are most of the quicksilver deposits, is an alluviated synclinal valley north of the Ciervo anticline. Northwest of Panoche Valley tightly folded rocks form the core of the main Diablo Range. Paralleling and crossing these folds are numerous faults, along some of which quicksilver deposits occur.

² Becker, G. F., *Geology of the quicksilver deposits of the Pacific Slope*: U. S. Geol. Survey Mon. 13, p. 380, 1888. Forstner, William, op cit. Anderson, Robert, and Pack, R. W., *Geology and oil resources of the west border of the San Joaquin Valley, north of Coalinga, California*: U. S. Geol. Survey Bull. 603, p. 207, 1915. Bradley, W. W., op. cit. Ransome, A. L., and Kellogg, J. L., op. cit.



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The sedimentary rocks consist of a thick sequence of marine sandstones and shales ranging in age from Jurassic through upper Miocene. These rocks include several formational units, most of which are bounded by unconformities. Igneous rocks of different kinds and ages intrude the oldest and youngest rocks; some lava flows are interbedded with the Jurassic and Miocene rocks, and others of probable Quaternary age, cap the beveled edges of the Miocene rocks. Recent unconsolidated deposits of landslide debris, valley alluvium, and terrace gravel mask the bedrock of a large part of the area.

The quicksilver deposits, although formed during the late Tertiary, have been found only in Jurassic and Cretaceous rocks. They are either on, or near, the major fault zones and their host rocks are characteristically silicified or kaolinized.³

Sedimentary Rocks

Jurassic Rocks

Franciscan Formation. The Franciscan formation, of probable Jurassic age, comprises the oldest, most widespread, and most diverse assemblage of rocks in the area, and is the host of almost all the quicksilver deposits (see Pl. I). It is composed mainly of sandstones and shales, although pillow basalts and closely associated cherts make up a considerable part of the formation. Neither fossils nor keybeds were found and for this reason the thickness of the formation was not measured; though at least a mile, if not several miles, of strata are represented. The Franciscan is distinguished from the younger formations by distinctive and varied types of igneous and metamorphic rocks. Compared with the overlying Panoche formation, the Franciscan rocks are more highly indurated and more intimately flexed and faulted, particularly south of Panoche Valley.

Sandstone is the dominant rock within the area studied and is most plentiful and best exposed northwest of Panoche Valley where it is massive to thin-bedded, gray to gray-green, medium- to fine-grained, and composed chiefly of quartz and feldspar grains. The sandstone here is less indurated and less disturbed than it is elsewhere in the district, as for example, at the head of Vargas Canyon, where it is tightly cemented and contains numerous small quartz veinlets.

Shale is less abundant than sandstone and usually occurs in partings between the sandstone beds, although in places there are shale lenses several hundred feet thick. The shale is black, thin-bedded, and silty to argillaceous. In some fault zones it forms a black, plastic, gouge-like substance, known among the California quicksilver miners as "black alta" because it often forms the hanging wall of orebodies.

Basaltic pillow lavas are interbedded with the sandstones and shales. In places these lavas are single flows only a few feet thick, but west of Bitterwater Creek, the Franciscan is composed almost entirely of pillow lavas which have a total thickness exceeding 5000 feet. The lavas are commonly altered to "greenstone," and where this alteration is intense they weather rapidly and are difficult to distinguish from weathered Franciscan sandstones. Even the most altered lavas, however, usually show some relics of igneous texture and pillow structures.

³ The term "kaolinized" as used in this report signifies hydrothermal alteration to any clay mineral, or minerals, and not specifically to the mineral kaolinite.

Cherts are commonly associated with the pillow lavas and are unquestionably related to them genetically. The chert is invariably near or in contact with the lavas. It is thin-bedded; individual beds, 1 to 6 inches thick, are separated by partings of shale or sandstone. Their color is most commonly some shade of red, but brown, green, black, and white varieties are fairly abundant. In places they are intricately folded.

In mapping the Franciscan formation no attempt was made to delimit the boundaries between rock types. Had this been done, it might have been possible to separate the formation into units; however, such an undertaking would have required more time than was available, as well as extensive mapping beyond the boundaries of the mineralized area.

Cretaceous Rocks

Panoche Formation. The Panoche formation, a thick sequence of sandstones and shales of Cretaceous age, overlies the Franciscan complex. It is in fault contact with the underlying rocks and is overlain in apparent conformity by the Cretaceous Moreno formation, or is overlapped by Tertiary rocks. A thickness of at least 5000 feet is represented in the area mapped, but in the nearby Panoche Hills the thickness is at least 21,000 feet.⁴ This thickness, however, includes units not now regarded as belonging to the "restricted" Panoche formation. Two of the quicksilver deposits in the district are in the Panoche formation.

The sandstone is more abundant than the shale and is a massive to medium-bedded, fine- to medium-grained rock composed essentially of quartz and feldspar. Where fresh it is blue gray, but it readily weathers to a light tawny yellow. The more massive varieties show cavernous weathering, and in many places contain large, hard, spheroidal concretions. Neither of these structures is a diagnostic criterion in separating the sandstone from the younger rocks, but each is useful in separating the Panoche from the Franciscan sandstone.

The shales in the Panoche formation occur as thin beds between more massive sandstone beds and, rarely, as members several hundred feet thick. They are silty to argillaceous, dark brown to black, and locally contain thin beds of brown sandstone.

In most places the Panoche rocks can be readily distinguished from the more disturbed and indurated Franciscan rocks. In places where the Franciscan is deeply weathered or hydrothermally altered, however, this distinction cannot always be made. For example, the Franciscan host rock for the ore deposits of the Valley View mine closely resembles the Panoche sandstone, and its true identity becomes apparent only when it is traced into unaltered sandstone.

Moreno Formation. The Moreno formation of upper Cretaceous age conformably overlies the Panoche. It is composed largely of chocolate-brown and lavender shales, is thin-bedded, and weathers to white, platy fragments. No quicksilver deposits have been found in this formation.

Tertiary Rocks

The older rocks of the district are overlapped by several thousand feet of marine sandstones and shales of Tertiary age. These rocks were divided by Anderson and Pack into several formations, and although the

⁴ Anderson, R., and Pack, R. W., op. cit., p. 44.

writers mapped them separately in the field, it was not practical to show them separately on Plate I. The divisions of Anderson and Pack are: the Cantua sandstone member of the Martinez formation, and the Tejon formation, both of Eocene age; the Kreyenhagen shale of Oligocene age; and the Vaqueros formation and undifferentiated beds of Miocene age. On Plate I the Eocene-Oligocene rocks are shown as one unit and Miocene rocks as another. No quicksilver deposits occur in Tertiary rocks.

Eocene-Oligocene Rocks. Although only a small area of Eocene-Oligocene rocks is mapped at the south end of Griswold Canyon, they extend for considerable distances to the east and west along the south flank of the Ciervo anticline.

The Cantua sandstone member of the Martinez formation consists mainly of massive, medium- to fine-grained gray sandstone which weathers to a tawny yellow. It is composed largely of quartz and feldspar grains, and contains numerous hard spheroidal concretions. Beds of dark clay-shale are intercalated with it. The sandstone is very similar to the Panoche sandstone; in fact some of the rocks near Buck Peak that were mapped as part of the Panoche formation, may really belong to the Cantua.

The Tejon formation, which overlies the Cantua sandstone member, is mainly a white to gray quartzose sandstone containing a few irregular pebble layers. The Kreyenhagen shale, overlying the Tejon formation, is a body of white diatomaceous and foraminiferal shale and clay-shale.

Miocene Rocks. The Miocene sedimentary rocks include the Vaqueros formation and the undifferentiated Miocene of Anderson and Pack. These rocks are exposed on the north limb and in a small down-warped area on the crest of the Ciervo anticline.

The Vaqueros formation consists of fine-grained, soft, brown sandstone, clay-shale, and diatomaceous shale. The sandy beds, particularly those near the base, contain several lenses of highly polished quartzite pebbles. In other respects the Vaqueros sandstone resembles the Panoche sandstone, except that it is softer and locally fossiliferous.

The undifferentiated Miocene of Anderson and Pack includes 500 feet of tuffaceous sand, basalt, and at least 200 feet of gritty, loosely aggregated sandstone and gravel. It is not known if these beds are a part of the Vaqueros sequence.

Quaternary Deposits

Unconsolidated deposits formed during the Quaternary comprise terrace gravels, valley alluvium, and landslides. These deposits cover almost half the area shown on Plate I.

The terrace deposits lie along the margins of Panoche Valley. Valley alluvium forms the floor of Panoche Valley, as well as the floors of the larger tributary valleys. Most of the landslides are in the Cerro Bonito hills.

The terrace deposits are composed of sub-rounded to rounded pebbles and cobbles derived largely from Franciscan and Cretaceous rocks. On the south side of Panoche Valley they are as much as 200 feet thick; on the northwest side of the valley they are somewhat thinner, and in places are merely a thin mantle on a rock terrace cut across Franciscan sandstones.

The floor of Panoche Valley is composed of an unknown thickness of fine silts, sands, and gravels.

Landslides are common south of Panoche Valley and are most numerous where the bedrock is fractured or is mostly shale. They are composed of angular blocks of rock, some of very large dimensions, embedded in a clay matrix. They range in size from those less than 100 feet across (too small to show on Plate I) to those covering areas of more than half a square mile. Some of them, notably the one at the Lea-Grant mine, grade into mud flows. They are in all stages of development; hummocky surfaces produced by soil creep represent the incipient ones, whereas older ones have deeply stream-entrenched surfaces.

Igneous and Metamorphic Rocks

Igneous and Metamorphic Rocks Associated with the Franciscan Formation

Igneous and metamorphic rocks of distinctive type are nearly everywhere associated with the sedimentary rocks of the Franciscan formation. Some, such as the pillow lavas and cherts already described, are contemporaneous with the sediments, and thus constitute members of the Franciscan formation. Others, such as the serpentine and its hydrothermal derivative silica-carbonate rock, were formed by the metamorphism of igneous rocks intruded into the Franciscan formation. Still others, such as the glaucophane and actinolite schists, are metamorphic derivatives of the Franciscan rocks. All these rocks are restricted to areas of the Franciscan formation and are therefore useful in identifying the formation in the field.

Bodies of intrusive diabase are common in the Franciscan south of Panoche Valley but are rare or absent in the Franciscan north of the valley. They are dark-green to black, fine- to medium-grained rocks, which are inclined to weather by crumbling. Much of the diabase is altered to greenstone, and thus resembles the greenstones derived from basaltic lavas. The exposures of less altered rock, however, still retain the typical diabasic texture.

Only one body of serpentine crops out in the area mapped. It is about two miles south of Llanada on Cerro Bonito Ridge and is about one-third of a square mile in area. It is a thin northward-dipping, sill-like body. There are two varieties of serpentine; the sheared and the unsheared or massive. The less common, massive serpentine is a dark blue-green rock, which still retains relics of pyroxene crystals. The sheared variety is commonly pistachio green and is devoid of any textures and structures which would suggest its original character.

Glaucophane, chlorite, actinolite, and other schists occur as small irregular lenses throughout the Franciscan formation. They are most abundant near the serpentine, but the largest body observed, on the hill south of the copper prospect, is not near any exposed serpentine body.

Miocene and Later Igneous Rocks

Numerous lava flows, plugs, and dikes of olivine basalt, as well as some tuffs, are exposed on the north slope of Cerro Bonito Ridge. Some of the flows and accompanying tuffs lie with apparent conformity on the Vaqueros beds. Other flows, tentatively assigned to the Quaternary period, cap the beveled edges of the Vaqueros beds, and appear to be related to an old erosion surface which slopes toward Panoche Valley.

Structure

General Character

The structure of the area is simple in general, but complex in detail. The major structural features are west-trending folds, northwest- to west-trending faults, and north- to northeast-trending faults. Numerous small faults and warps of diverse trends complicate the main structural pattern. Movement on the northwest- and west-trending faults began before the end of the Cretaceous, and probably continued intermittently throughout the Tertiary. The north and northeast faults were probably formed during the Tertiary, perhaps late in that period. The folds involve beds as young as Miocene, and the overlapping relationships of formations indicate that folding began before the deposition of the Panoche sediments. There is no apparent reason, however, to believe that folding has ever been independent of faulting.

Folds

Folds are prominent structural features of the area. The most important one is the Ciervo anticline which crosses the southern part of the area shown on Plate I. Just north of the Ciervo anticline, between Cerro Bonito Ridge and Llanada is a small syncline of Miocene rocks. North of this syncline lies the alluviated synclinal Panoche Valley. Individual folds in the Franciscan rocks northwest and west of Panoche Valley are not readily apparent because of complication by east-trending faults.

The Ciervo anticline is a broad fold which extends 12 miles eastward beyond the eastern boundary of the mapped area (Pl. I) and westward as far as Vargas Canyon, where it apparently ends against a northwest fault. Griswold Creek cuts across the anticline where the trend of the axis is about N. 70° W. Here the south flank is nearly symmetrical, but the north flank is complicated by minor folds, which appear to have controlled the localization of ore at the Lea-Grant mine. One mile west of Griswold Creek a local warp in the crest of the anticline is marked by exposures of Miocene rocks (see Pl. I).

The Miocene rocks south of Llanada are folded into an east-trending syncline whose symmetry is destroyed by numerous minor folds and faults, a few of which are shown on Plate I. Panoche Valley is a structural as well as a topographic valley, but its synclinal form is probably the product of both folding and faulting. In the main Diablo Range, northwest and west of Panoche Valley, the Franciscan rocks are closely folded, but no attempt was made to map individual folds.

Faults

All the rocks, from Jurassic to Miocene, are cut by two main sets of faults. Some of these faults are of the strike-slip variety, and trend west to northwest. Although they are probably the oldest in the region, having been outlined before the end of the Cretaceous, they have also been active since the Miocene. For the most part, they appear to be terminated by a major group of normal faults striking north to northeast.

In addition to these, there are numerous north-striking low-angle thrust faults near the Valley View mine (see Pls. I and IV). These are of unknown age, but are certainly younger than the folding of the Franciscan rocks, and there have been slight movements on them since the quicksilver mineralization.

Before the end of the Cretaceous, the rocks were folded and faulted in a general northwesterly direction. At this time the northwest- and west-trending faults were outlined. Later orogenic movements throughout the Tertiary repeatedly folded and faulted the rocks. Some of these later movements followed the old faults in the Franciscan rocks, and without doubt, newer fractures were also formed in these older rocks. Repeated rejuvenation of the old faults created new faults in the overlying younger rocks. In some places renewed movements on the old faults were not of sufficient magnitude to do more than locally warp or slightly fracture the overlying rocks. The two broken anticlinal folds, shown on the map and structure sections of the Lea-Grant mine (Pl. III), may be the result of movement on westward-trending faults in the underlying Franciscan rocks. If the two westward-trending faults which bound the Franciscan block south of Llanada are projected eastward they coincide with the two anticlinal folds on the Lea-Grant property.

Most of the faults within the Franciscan formation are fault-breccia zones, which in places are over 100 feet wide. The breccias are composed of lenticular and subangular fragments of all kinds of Franciscan rocks in a finely pulverized shale matrix. The lenticular breccia fragments are roughly aligned along that trend of the fault zone. Throughout the breccia zones, and parallel or subparallel to them, are the shears with both cut and wrap around breccia fragments. These breccia zones are best seen in mine workings, notably at the Mercy mine. On the surface they can seldom be examined in detail, except in creek bottoms where erosion is active. They produce such topographic lows as stream valleys and ridge saddles, and in many places their presence is suggested by incipient landslides.

QUICKSILVER DEPOSITS

The quicksilver deposits of the Central San Benito district consist of irregular veins and disseminations of cinnabar or metacinnabar in host rocks of silicified or kaolinized sandstone, in fault breccia, and in silica-carbonate rocks. Prominent fault zones enclose, or are near, all the deposits except one, and the warped and irregularly fractured rocks at this deposit are possibly the surface expression of an underlying major fault. Most of the orebodies are irregular and of little horizontal and vertical extent. Their locations and forms are controlled by minor faults and fractures and by the character of the wall and host rocks. The deposits are characteristically "spotty", consequently the grade of ore varies between wide limits. The ore reserves are not amenable to measurement. It is probable, however, that a small but fluctuating production will be maintained as long as the price of quicksilver is above \$175 per flask.

Mineralogy

Cinnabar, the red sulphide of mercury, and metacinnabar, the black sulphide of mercury, were the only quicksilver minerals observed in the district. Cinnabar is the more important of the two, although metacinnabar is the only important ore mineral in the Valley View mine and is probably present in minor amounts in most of the other deposits. Both minerals occur as crystalline fillings and incrustations in fractures and

other openings. Cinnabar also occurs in a pulverulent form commonly called "paint", which coats joint and fault surfaces. The genetic relationship between cinnabar and metacinnabar is not clear, but study of a polished specimen under the microscope suggested, but did not prove, that the former had replaced the latter. Replacement undoubtedly had some part in the deposition of the quicksilver minerals but it was probably less important than the filling of openings.

Cinnabar is so common and easily recognized that it does not deserve further description. Metacinnabar, however, although rarely an important ore mineral is more widespread than is commonly believed, and is not as easily recognized. Hence, a few words of description are pertinent. Metacinnabar, or metacinnabarite, as it is also called, has the same chemical composition as cinnabar (HgS), but crystallizes in the isometric instead of the hexagonal system. The crystalline variety has a metallic luster and is grayish black, but may have a reddish cast from included cinnabar. Its streak is black, in contrast to the scarlet streak of cinnabar, and it is slightly harder. The mineral is brittle and its fracture is sub-conchoidal to uneven. It also occurs in massive and amorphous varieties. Where finely disseminated it may resemble any of the common dark rock-forming minerals, and in panning it may be thrown away in the belief it is a black sand.

Other sulphide minerals in the district are pyrite and marcasite, which occur closely associated with the cinnabar. They appear to be most common in the deposits described as fault-breccia deposits. A little chalcopyrite was reported⁵ in a quartz vein at the Mercy mine, but this occurrence was not seen by the writers. The chalcopyrite is probably the product of an earlier mineralization and not of the cinnabar mineralization. Other copper minerals, mostly carbonates, are at the Copper prospect, three miles northeast of the Valley View mine in NW. $\frac{1}{4}$ sec. 33, T. 14 S., R. 10 E., M.D., but this deposit was not studied.

The gangue minerals are: the grains of the country rocks enclosing the ore; the quartz, opal, chalcedony, and carbonates that form the silica-carbonate rock; quartz and chalcedony in veins in the sandstone and breccia deposits; and clay minerals and the iron oxides hematite and limonite. The deposits in silica-carbonate rock contain minor amounts of black, amorphous hydrocarbons which coat rock cavities and are definitely later than the cinnabar.

Rock Alteration

All the quicksilver deposits are surrounded by zones of hydrothermally altered rock. These zones commonly enclose the faults along which the orebodies are located. Depending upon original composition, several different kinds of altered rock were produced during what is believed to be one general period of hydrothermal activity. While the serpentines were altered to silica-carbonate rock, the sandstones were kaolinized, and fault-breccia zones were locally cemented and replaced by silica to form quartz and chalcedony veins.

Much of the serpentine on Cerro Bonito Ridge is altered to "silica-carbonate rock" composed essentially of silica and carbonate. This rock is also known by miners throughout the California Coast Ranges as "quicksilver rock" because of its close association with many of the

⁵ Anderson, R., and Pack, R. W., op. cit., p. 207.

quicksilver deposits. Silica-carbonate rock consists mainly of chalcedony, opal, quartz and carbonates in varying proportions. The silica, however, is usually dominant over the carbonates, and also occurs as later quartz veinlets. In places, especially where the serpentine was not completely converted into silica-carbonate rock, the altered rock retains the slickensides and shear structures of the serpentine; in other places, where the serpentine is completely replaced, the silica-carbonate rock is massive, retaining no original textures and structures but containing small flecks of chromite and picotite that betray its derivation.

Silica-carbonate rock weathers to prominent and distinctive outcrops of rust-brown to light-tan porous, cellular rock. Where it is rich in silica it forms reefs, cliffs, and knobs that stand out in bold relief from the more subdued topography of the serpentine.

Where the quicksilver deposits are in either Franciscan or Panoche sandstone, the rock immediately surrounding them is altered to a light buff to cream-colored soft, somewhat porous rock. The altered character of this rock is largely the result of the conversion of many of the feldspar grains to clay minerals. Most zones of altered sandstone are along faults, the altered rock extends out from the fault from a few feet to several hundred feet. On the aerial photographs they are readily visible as elongate light-colored bands.

Within the zones of kaolinized sandstone as well as within the fault-breccia zones siliceous ribs or veins mark minor fault and shear planes. These veins are composed of dark quartz or chalcedony and commonly show repeated brecciation and cementation. They are from 1 inch to 5 feet thick and from a few feet to several hundred feet long. They are best developed at the Mercy and Valley View mines where the orebodies have a direct relationship to the distribution of the veins. At both of these mines the veins are highly polished and slickensided along their walls and along internal shears.

Form and Character

The quicksilver deposits occur as vein and disseminated deposits and are classified according to their host rocks as follows: (1) deposits of cinnabar or metacinnabar in Franciscan or Panoche sandstone, exemplified by the Valley View and Lea-Grant mines; (2) deposits in Franciscan fault breccia, exemplified by the Mercy mine; (3) deposits in silica-carbonate rock, exemplified by the Cerro Bonito mine. The first two of the above types overlap. The above classification is not genetic and is used only for convenience in description.

Deposits in Sandstone. The deposits in sandstone, the most common type, consist of fillings of cinnabar in fractures, and of impregnations of cinnabar in the host rock. Many of these deposits are localized along a single fault plane and thus assume a vein-like form; others are composed of numerous veins along intersecting fractures of diverse trends and thus have irregular pipe-like forms. The veins are characteristically irregular; they range from a fraction of an inch to over 4 feet wide and pinch and swell both horizontally and vertically. Few individual orebodies are over 50 feet long, but they are distributed sparsely along a single fault for over a mile. In December 1941 none of these orebodies had been explored for more than 75 feet below the surface; consequently little is known of their vertical extent. Gouge- and clay-coated walls of the frac-

tures, with few exceptions, appear not to have played an important part in localization of the ore minerals. Porosity of the sandstone appears to be the important factor.

Deposits in Franciscan Fault Breccia. The deposits in Franciscan fault breccia consist of fillings of cinnabar in openings, and impregnations of cinnabar in breccia fragments. The orebodies commonly have a vein-like form within the breccia mass, although in some places the ore is extremely spotty and is confined only to certain kinds of rock within the breccia. In places the ore extends into the unbrecciated wall rock of the fault zone, particularly where that rock is sandstone. In size and form the breccia deposits are similar to the sandstone deposits. Sandstone blocks and fragments in the breccia are usually altered, as is the sandstone surrounding the breccia zone. Quartz veins, gouge seams, and shears within the breccia body controlled the local distribution of the ore. The Mercy mine and the Yturriarte mine are the only deposits essentially within Franciscan fault-breccia zones.

Deposits in Silica-Carbonate Rock. Deposits in silica-carbonate rock consist of irregular disseminations and small veinlets of cinnabar which in aggregate form tabular or pipe-like shoots. Most of the cinnabar is along small fractures. The only two examples of this type of deposit, the Cerro Bonito and Cerro Gordo mines, unfortunately, were for the most part inaccessible during the field work; consequently, detailed information about these orebodies is lacking. Fragmentary information gleaned from old reports is included in the descriptions of the individual mines. The silica-carbonate quicksilver deposit is the most common type in the California Coast Ranges.

Origin

The close association of all the quicksilver deposits with fault and fracture zones, and their distribution within zones of hydrothermally altered rocks favor the conclusion that the deposits were formed by hydrothermal solutions which rose chiefly along fault channelways. Their position within fault zones which have undergone considerable movement since Miocene time, without noticeably disturbing the deposits, suggests that their age is Pliocene or later. From the above facts and other evidence not pertinent to this report, a probable origin of the quicksilver deposits is deduced.

Late in the Tertiary solutions rose along faults which were recurrently active. These solutions attacked the serpentine, forming carbonate-rich rocks, and kaolinized the sandstones along the channelways. This early mineralization was followed or, more likely, was overlapped by the introduction of solutions which silicified the partly altered serpentine and formed chaledony and quartz veins and veinlets within the kaolinized sandstone. Sufficient minor movements occurred on the faults during this mineralization to keep the channelways open, and to fracture the altered rocks, either during the final stage of silicification or somewhat later. As these ore-bearing solutions approached the surface they entered a physical environment of decreased temperature and pressure which enabled them to precipitate their mercury, iron, and sulphur as cinnabar, metacinnabar, pyrite, and marcasite within openings in the fault zones and wall rock. Concentrations of these minerals were formed

where conditions of temperature and pressure and wall-rock character highly favored deposition, or where relatively impenetrable walls forced great volumes of solution through restricted channels.

Grade of the Deposits

The grade of ore in the individual shoots has a wide range. No information was obtained concerning the grade of ore mined in early operations, but in all probability it would today be considered as high, judging from material left on the dumps. Sorting operations were practiced then, as now, because the volume of ore that could be treated in the reduction plants was limited. It seems possible that ore averaging 20 pounds or more of quicksilver to the ton was treated in the old coarse-ore furnaces at the Mercy and Cerro Bonito mines. Mining practices determine the grade of ore extracted; that is, the amount of waste rock removed along with the ore minerals. In the present small operations the grade of ore is fairly high, mostly because it is selectively mined. The Lucky Strike mine produced in 1941 more than 100 flasks of quicksilver from ore which averaged over 200 pounds of quicksilver per ton. This grade, however, was obtained by selective mining; if all the rock stoped had been considered, the grade would have been reduced to less than 10 pounds of quicksilver to the ton. The other small mines retort ore which averages from 5 to 20 pounds of quicksilver to the ton. Of the larger operations during 1940 and 1942, the Valley View mine burned 15,000 tons of ore and recovered 294 flasks of quicksilver for an average grade of $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds of quicksilver per ton. The Lea-Grant averaged over 2 pounds of quicksilver per ton. Ore at the Mercy mine has averaged considerably more than this.

Reserves and Future of the District

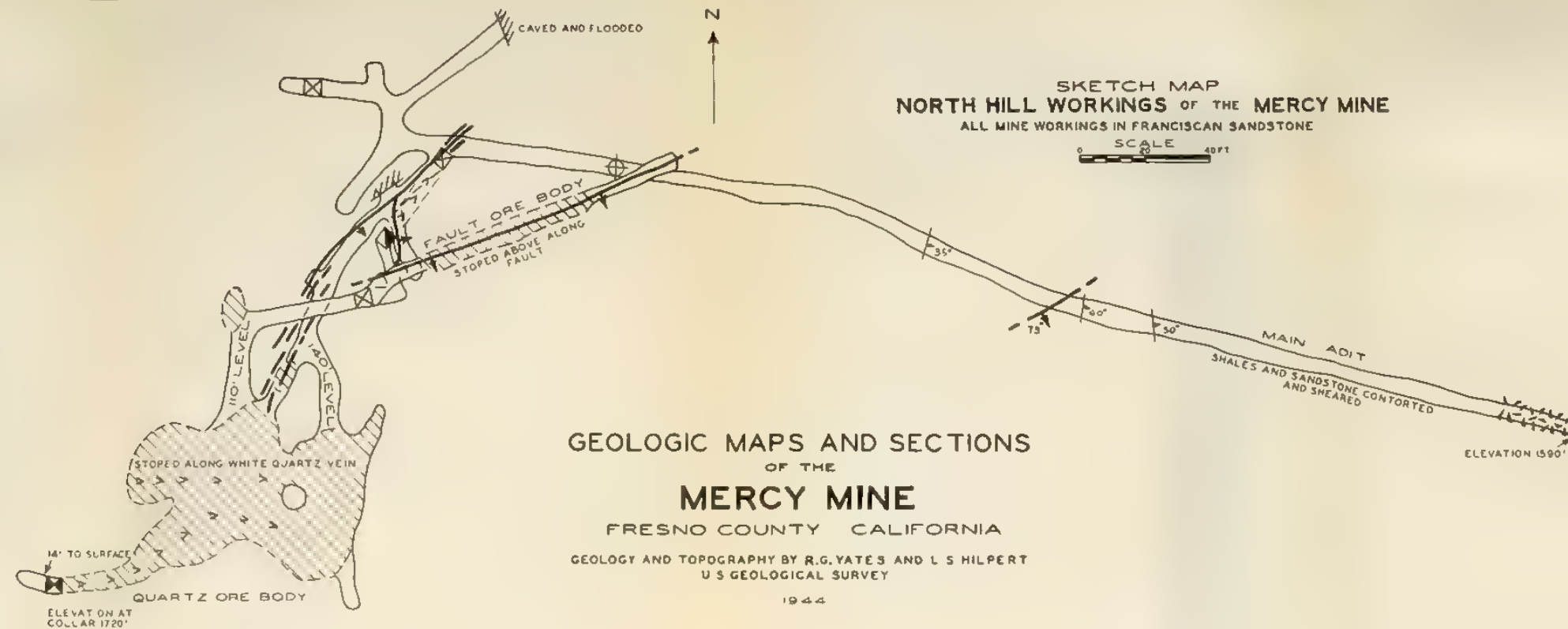
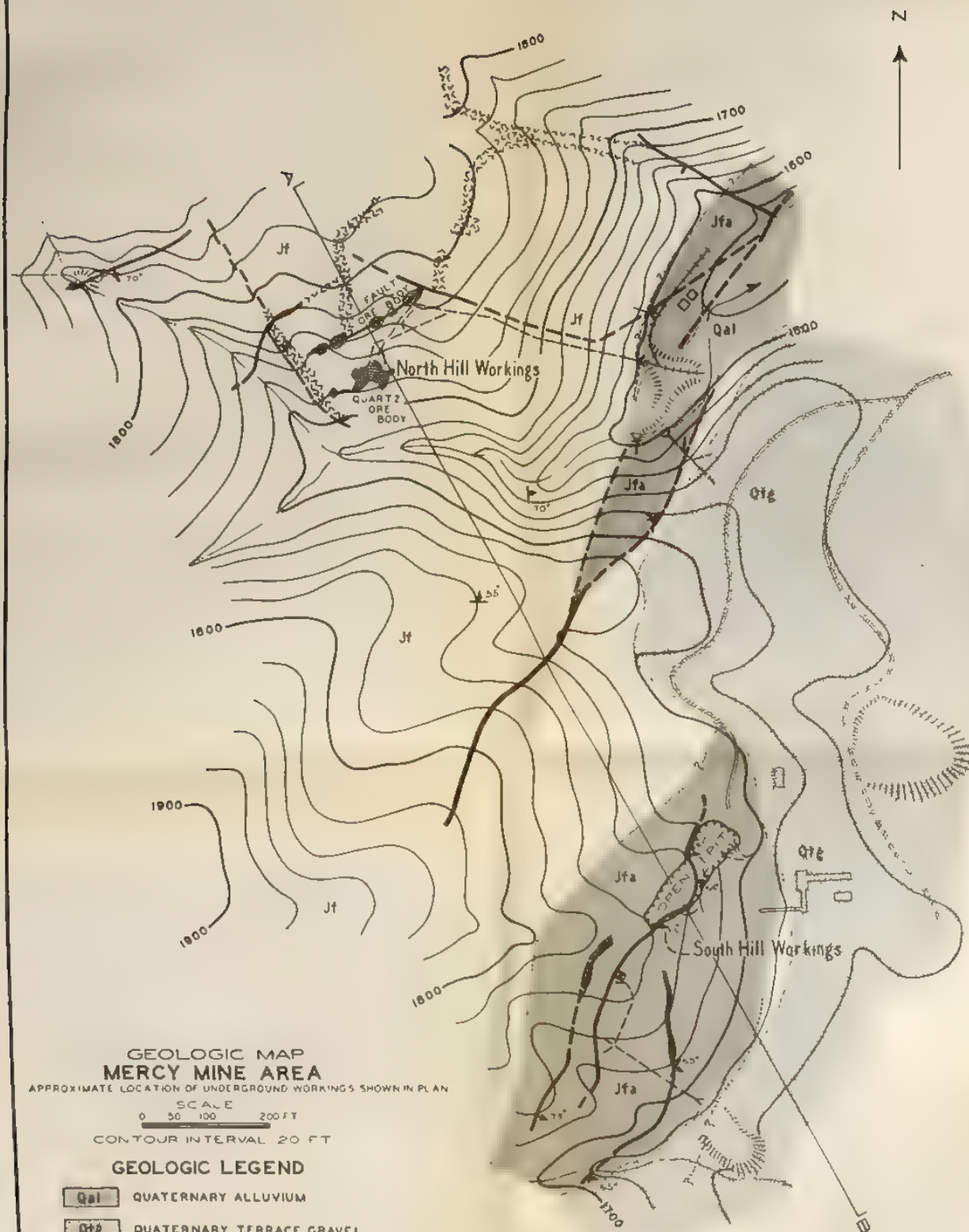
General mining practices and the geologic nature of the deposits prohibit any measurement, or even reasonable estimate, of ore reserves. Orebodies in the district are not explored in advance of mining; instead, removal of ore begins immediately after discovery, without any knowledge of the extent of the orebody. Consequently, the history of any mine is one of periodic production and prospecting. The small size, erratic distribution, and irregular nature of the orebodies partly justify this practice, although mining by such methods is expensive in the long run and is not conducive to continued operation and production.

As long as high prices stimulate interest in mining and prospecting, the district will have a continued, fairly stable production, probably comparable to that of 1940. If prospecting lags or the price declines and some of the mines close, production will not only materially decrease but will become very erratic.

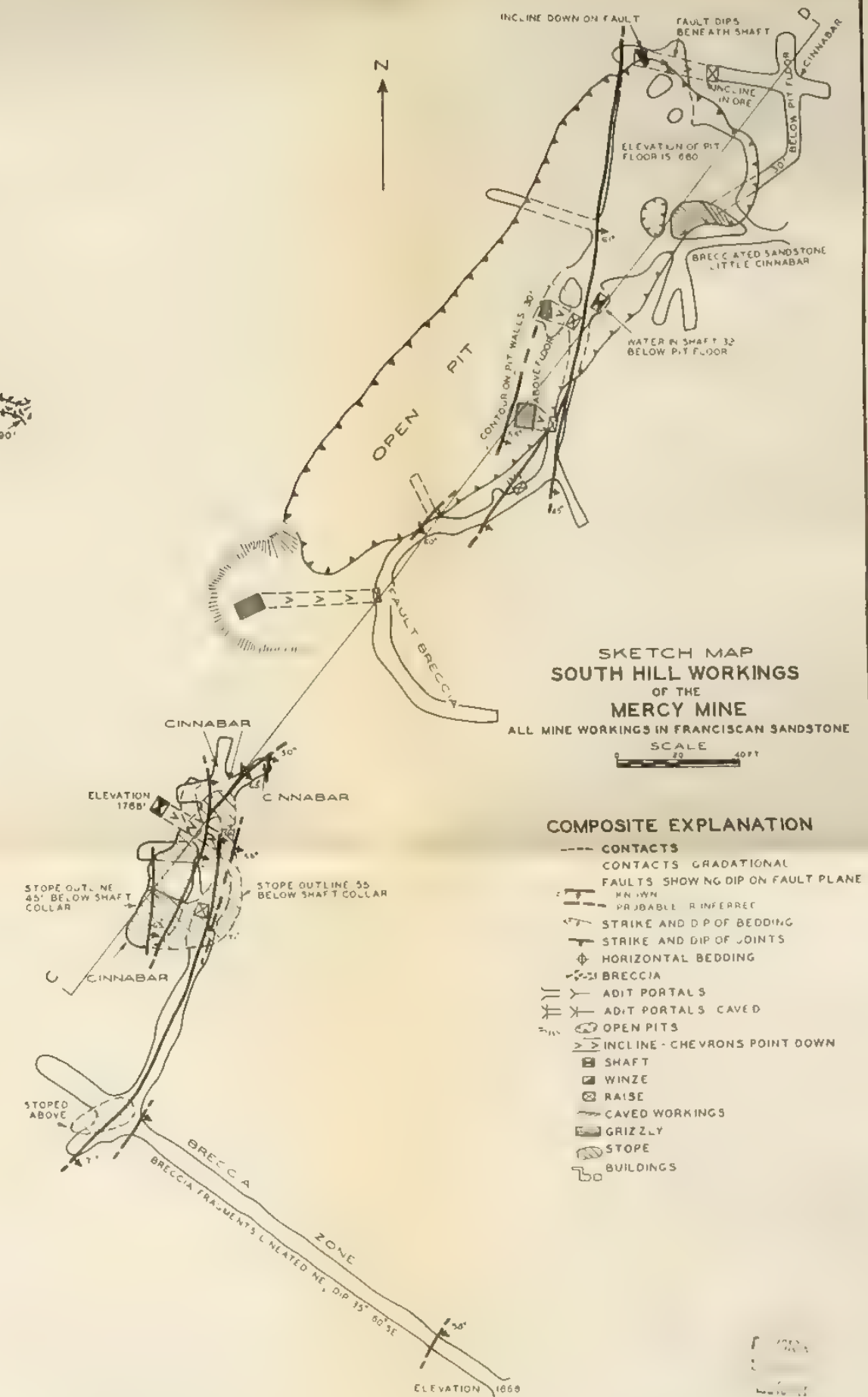
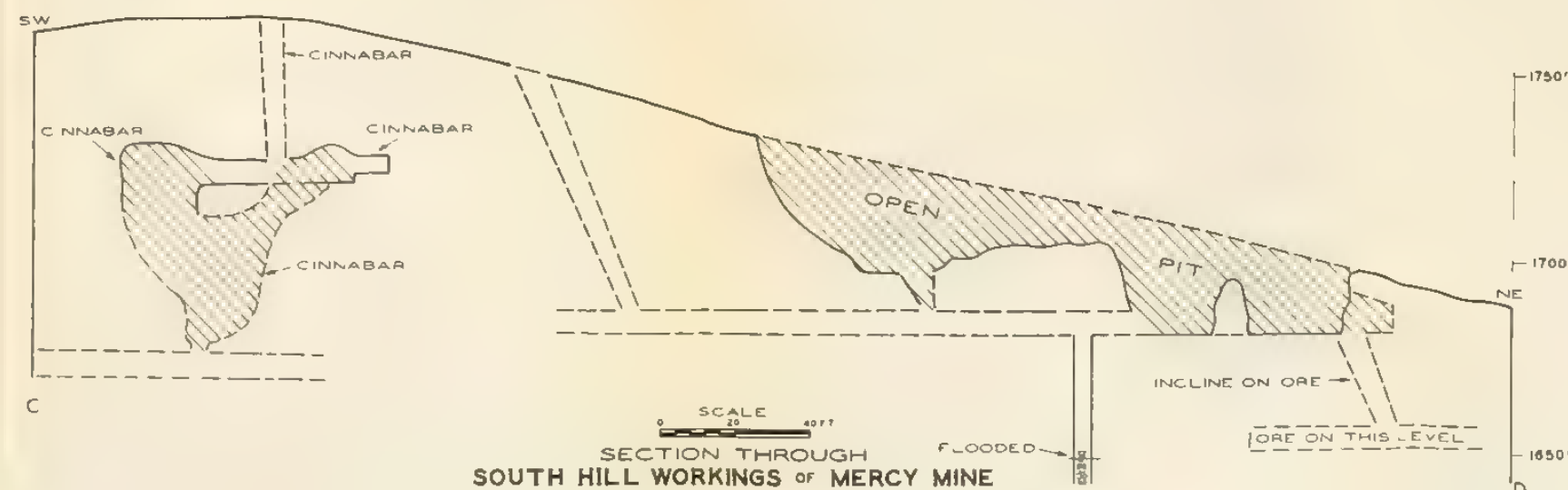
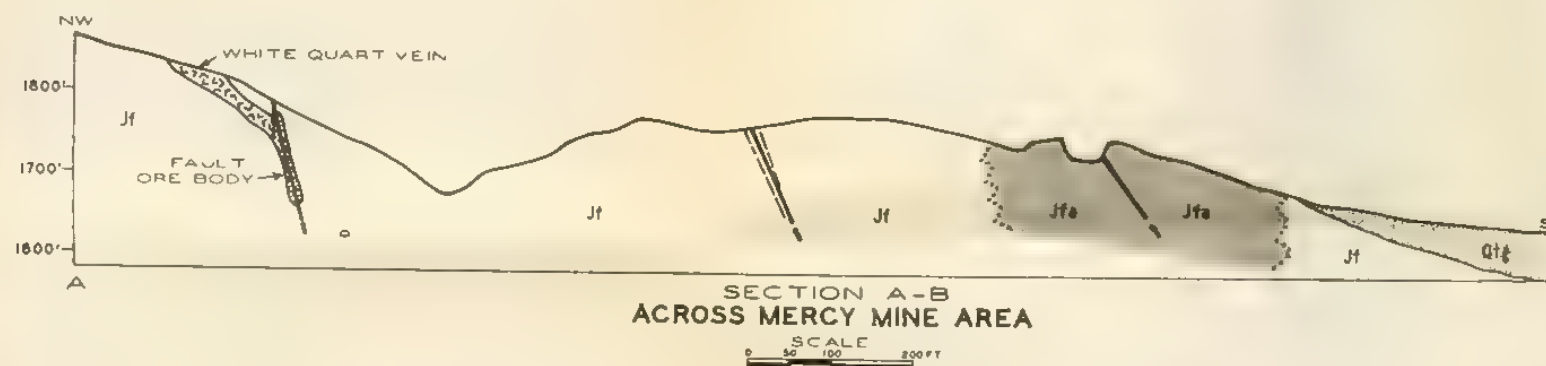
Suggestions for Prospecting

The geology of the district reveals certain broad generalizations which should be useful guides in prospecting. The constant association of the quicksilver deposits with fault or fracture zones and with silica-carbonate rock or kaolinized sandstone is not fortuitous, but the result of a genetic relationship. It is likely that future discoveries will be associated with similar structures and similar zones of altered rock.

Areas favorable for prospecting are indicated by means of fault and rock-alteration symbols and patterns on the geologic map of the area



**GEOLOGIC MAPS AND SECTIONS
OF THE
MERCY MINE**
FRESNO COUNTY CALIFORNIA
GEOLOGY AND TOPOGRAPHY BY R.G. YATES AND L.S. HILPERT
U.S. GEOLOGICAL SURVEY
1944



- COMPOSITE EXPLANATION**
- CONTACTS
 - CONTACTS GRADATIONAL
 - FAULTS SHOWING DIP ON FAULT PLANE
 - MIN. MIN. PROBABLE INTERPRET
 - STRIKE AND D.P. OF BEDDING
 - STRIKE AND DIP OF JOINTS
 - HORIZONTAL BEDDING
 - BRECCIA
 - ADIT PORTALS
 - ADIT PORTALS CAVED
 - OPEN PITS
 - INCLINE - CHEVRONS POINT DOWN
 - SHAFT
 - WINZE
 - RAISE
 - CAVED WORKINGS
 - GRIZZLY
 - STOPE
 - BUILDINGS

about Panoche Valley (Pl. I). In addition to these, there are other smaller areas, which neither the map scale nor available time permitted showing. Areas between Panoche Valley and the Cerro Gordo and Mercy mines were not mapped. If, as seems likely, these areas are related structurally, the intervening areas may also be favorable for prospecting. More specific recommendations are included under the descriptions of the individual mines.

MINES

All the accessible mines in the district are small; the largest has 2000 feet of workings and many have only several hundred feet, or less. The deepest is the Cerro Bonito mine, the lower adit of which is 600 feet below the surface outcrops. The Bitter Water mine and the properties west of the Valley View mine are hardly more than prospects, but as all have a recorded production they are described herein as mines.

Mercy Mine

The Mercy mine (formerly *Mercey*, also *Pacific*) is on Mine Creek, a tributary of Little Panoche Creek, 25 miles southwest of South Dos Palos. The mine proper is in sec. 5, T. 14 S., R. 10 E., M. D., but the mining claims extend into adjoining secs. 32 and 33, T. 13 S., R. 10 E. It is the leading producer in the district with a total recorded production of 1682 flasks of quicksilver. Mexicans started mining cinnabar about 1860, but it is reported that the property had been explored earlier for silver. In 1911 the Pacific Quicksilver Company took over the mine, enlarged the operations, and installed a 24-ton Scott furnace, which was operated until about the end of 1914. Since then operation has been intermittent.

The property consists of a group of claims which have been variously divided and worked by many operators. It is roughly divisible into two groups of workings; those south of the small creek crossing the property (see Pl. II) are herein referred to as the South Hill workings; and those north of this creek are referred to as the North Hill workings. In May 1941 C. W. Hickok was operating the South Hill workings and Mr. Wahlford was operating the North Hill workings. By July of that year Wahlford had discontinued operations and the North Hill workings were idle. At that time a 40-ton rotary furnace was in operation on the South Hill workings.

In March 1944 ownership of the property north of the creek was divided between W. M. Biaggi, F. Burell, and Wm. Di Napoli, all of San Jose; and workings south of the creek were divided between F. Burell and L. S. Albertini, of San Jose. By that time the rotary furnace had been removed from the South Hill workings and the workings both north and south of the creek were idle.

South Hill Workings. The South Hill workings of the old Mercy mine were operating in 1941 under the old, but unfamiliar, name "Arramedia." These workings in 1941 (Pl. II) consisted of over 1000 feet of tunnels, crosscuts, raises, winzes, and drifts, and an open pit 200 feet long, 50 feet wide, and about 30 feet deep. At the time of the examination the open pit was not connected underground with the workings to the south.

Most of the workings are in kaolinized Franciscan sandstone which encloses a zone of hydrothermally altered Franciscan fault breccia that trends N. 30° E. To the northeast this zone passes beneath a thick blanket of Quaternary terrace gravels. The altered zone includes several parallel ribs, or veins, of dark massive brecciated quartz, polished and slickensided by fault movement. These veins are from several inches to over three feet thick, strike to the northeast and dip from 50° to 75° S. The most persistent and prominent one extends through the mine workings and controls the distribution of the ore.

In the South Hill workings ore has been mined from the open pit and from workings to the south. Possibly these two shoots are parts of the same orebody. Cinnabar occurs with iron sulphides as impregnations in breccia fragments, as crystal fillings in fracture openings in the breccia, and as impregnations in the altered sandstone. Shoots of high-grade ore were erratically distributed along the orebody, but much of the intervening lower-grade material could be profitably mined in 1941. The southernmost ore shoot was 40 feet long and 20 feet wide and extended from the surface to a depth of over 90 feet, where it apparently ended. The north ore shoot, or that of the open pit, is larger and was probably richer. High-grade streaks were located on or near the silicified rib, but much of the altered breccia and sandstone several feet from the rib also carried considerable cinnabar. In the north end of the pit the silicified shear apparently acted as the footwall of the deposit, as is evidenced by the small amount of mineralization in the short crosscut which extends west of the shear.

The orebody in the open pit was locally as much as 20 feet wide and extended throughout the pit from south to north. It appears to pitch to the northeast but has not been sufficiently explored below the bottom of the pit to determine this with certainty. The vertical shaft in the center of the pit (see Pl. II) is flooded at a depth of 32 feet. At the extreme north end of the pit an inclined winze explores the orebody to a depth of 30 feet below the pit floor. This winze goes down on ore, and at the intersection with the crosscut extending east from the bottom of the winze there is another good showing of cinnabar.

Most of the mining done in the summer of 1941 consisted in the removal of low-grade ore overlooked in earlier operations. Much of this ore contained six pounds or more mercury to the ton and included several high-grade pockets.

The two ore shoots of the South Hill workings, although possibly parts of the same orebody, are separated by about 75 feet of ground, which probably will yield some low-grade ore. It is interesting to note that both ore shoots are on parts of the silicified shear where it has a strike of about N. 15° E., and that between the shoots the shear strikes in a more northeasterly direction. Possibly the more northerly trending shears were most favorable to mineralization; if so, more ore shoots may be found under the gravel cover north and east of the north end of the open pit.

Any further development of the mine should explore below the present workings and also explore along the trend of the breccia zone in the rocks below the gravel cover.

North Hill Workings. Included in the North Hill workings, formerly called the "Aurrecochea," (see Pl. II) are several hundred feet

of drifts, crosscuts, and stopes, most of which were made during the last century. The deepest work in this part of the Mercy mine is 140 feet below the outcrops of the orebodies. There is no connection with the South Hill workings.

The rock of the North Hill workings is similar to that of the South Hill workings except that the zones of kaolinized sandstone are smaller and more erratic. Several veins of white, coarsely crystalline quartz are exposed on the hill. In general, these have a northerly strike and easterly dip and are a few inches to over 10 feet thick. The ribs or veins of silicified breccia common to the South Hill should not be confused with these white quartz veins, which were probably formed earlier than either the cinnabar deposits or the silicified breccia ribs.

Almost all the ore mined from the North Hill workings came from two separate orebodies both of which are apparently exhausted. One of these orebodies was in, and along the border of the westernmost white quartz vein (see Pl. II). The other was along a fault marked by a silicified rib similar to those at South Hill. For convenience in description, these two orebodies are referred to as the Quartz and Fault orebodies, respectively.

The Quartz orebody has a northward strike and an eastward dip of about 55° . Its surface outcrop was small and inconspicuous and was located at the collar of the shaft 480 feet S. 85° W. of the portal of the main adit. The orebody enlarged downward and on the lowest level, 140 feet below the shaft collar, the stope dimensions are 30 by 20 feet. Below this level the stope is flooded and could not be examined. It is doubtful, however, if it extends much deeper, as the quartz vein which controlled the orebody breaks up there into a number of small quartz stringers. The ore was both within and along the borders of the quartz vein. Within the quartz vein cinnabar occurred in fracture and interstitial openings and as coatings along seams of black gouge; along the vein it occurred as fine impregnations in the altered sandstone wall rock. The writers were unable to learn the grade of this orebody, but probably parts of it were rich.

The Fault orebody is just northeast of the Quartz orebody (see Pl. II) and was exploited by means of the same adit. The fault, along which the orebody formed, strikes N. 60° E. and dips steeply to the southeast. On the surface it crops out for 200 feet; it terminates to the east against a slightly mineralized northwest-trending fault, and to the west dies out near a wide northwestward-trending quartz vein. It extends from the surface to below the 110-foot level, but does not reach the main adit level. The stope extends for over half the distance of the surface outcrop of the fault, and pitches eastward along the fault from the surface down to the 110-foot level. Along the sublevel the orebody was stoped for over 80 feet, where it was four to six feet wide. It did not extend below the sublevel, but may possibly have had an extension north of the main adit on the north side of the northwestward-trending fault. The cinnabar in the Fault orebody shows the same relation to the sandstone and veins as in the Quartz orebody.

In addition to the principal North Hill and South Hill workings, there are at least two other places where cinnabar has been mined. One is about 100 feet south of the portal of the main adit of the North Hill workings in a breccia zone which trends about N. 30° E. along the creek

bottom, where it is mostly covered by alluvium. Of the two adits which explore this zone (shown on Pl. II, south of the creek), only one was open at the time of examination. Thirty feet from the portal a small slope extends up about 15 feet, along the walls of which a little cinnabar remains. The second place of cinnabar mineralization is at the northeast edge of the mapped area along a silicified shear which strikes N. 70° W. and dips steeply south. The cinnabar occurs as a narrow vein along the shear, and was explored by two short adits and an inclined winze. This shear, as well as the breccia zone along and south of the creek, are both worthy of further exploration.

Lea-Grant Mine

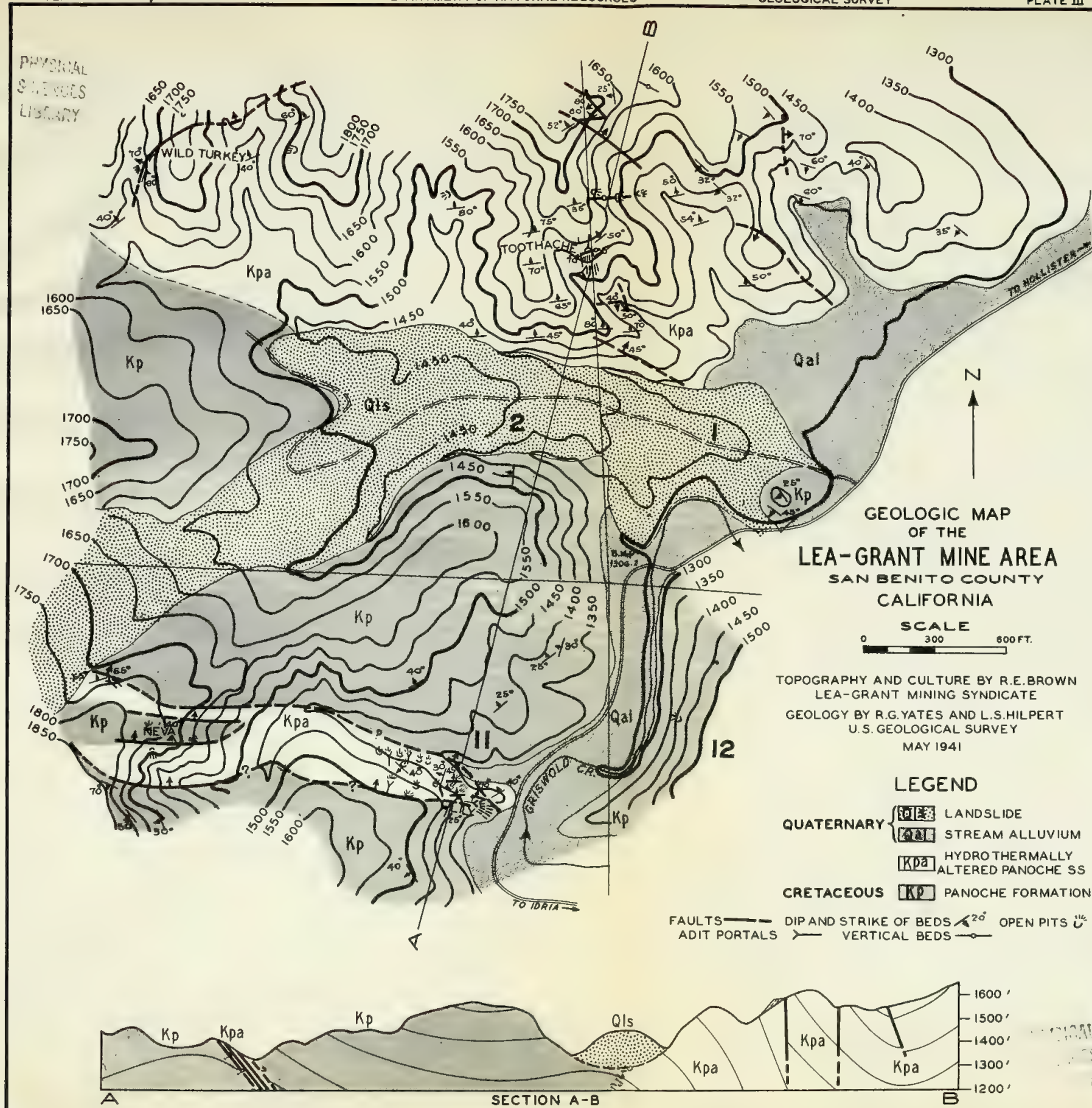
The Lea-Grant mine is near the mouth of Griswold Canyon eight miles southeast from Llanada on the surfaced highway that leads to Idria. The property, which includes parts of secs. 1, 2, 11, and 12, T. 16 S., R. 10 E., M. D., was owned in 1941 by Lily Berg of Hollister, California, and was leased to Spencer Grant and R. W. Lea of San Francisco. It was managed by E. H. L. Mitchell, who discovered the deposit in 1940. In December 1941 the mine workings consisted of numerous small adits, most of which were less than 100 feet long, and many of which are only prospect cuts. Total production up to 1943 inclusive was 706 flasks of quicksilver, most of which came from ore averaging about two pounds of quicksilver per ton. The ore was roasted in a fifty-ton rotary furnace on the property.

The mine occurs in Panoche sandstone on the north flank of the Ciervo anticline (see Pl. I) where it has been flexed into two minor folds. Along the strike of these minor folds are two east-trending zones of mineralization, marked by fractured, crushed, and altered rock (see Pl. II). The south zone is along an east-trending fault which can be traced to the western edge of the mapped area (Pl. III). The north zone is broken by numerous small faults which have neither continuity nor much displacement. As mentioned above, the two minor folds and accompanying mineralized zones may be the surface expression of a larger fault, or faults, in the underlying Franciscan rocks.

The southern mineralized zone is the more regular of the two. Most of the faulting here is in a west to northwesterly direction. The fractured and altered zone is locally over 200 feet wide and is over 1800 feet long. Cinnabar is found at both ends of the zone, but the middle part appears to be barren. The Lily workings best illustrate the irregular bodies of crushed and relatively uncrushed rock of the south mineralized zone. Very little cinnabar is visible in the Lily workings, except for a small amount disseminated in the altered and crushed sandstone. The Neva prospect at the west end of the south zone is typical of that part of the area.

The northern mineralized zone is not as well defined as the south zone, but, in general, it extends across the northern third of the mapped area (see Pl. III). The rocks are altered in a similar manner, but show fewer and more erratic fractures. The two most important areas of cinnabar mineralization are the Wild Turkey, at the west end of the zone, and the Toothache, in the east-central part of the zone.

The Wild Turkey adit was driven along a series of northeast shears which dip steeply to the northwest. The sandstone adjacent to the





shears is fractured and the cinnabar occurs as coatings on the fracture surfaces and to a slight extent as impregnations in the sandstone. Gypsum is commonly associated with the cinnabar.

The Toothache and nearby workings have the best showings of cinnabar, and most of the ore mined up to December 1941 came from them. They consist of three short adits, the lowest of which is about 100 feet vertically below the uppermost. When visited, the lowest workings had not been driven far enough into the hill to test a vertical projection of the upper orebodies. An ore shoot in the Toothache area, however, was mined for over 30 feet vertically and was locally as much as 10 feet in diameter. This was mined after the field work, and is not shown on the sketch map. The cinnabar occurs as coatings on fracture surfaces of the sandstone and as impregnations in the more altered sandstone.

The irregular nature of the fractures and spotty nature of the orebodies make the Lea-Grant property difficult to mine. Further exploratory work must be done before any extensive development can be planned. In a few places the ore is of high grade, but most of the cinnabar-bearing rock is of low grade; consequently, if the present plant is to be kept in continuous operation a high percentage of low-grade ore must be mixed with the high grade.

Valley View Mine

The Valley View mine (also known as the *Panoche*) is on the west edge of Panoche Valley, about 2 miles north of Llanada, in secs. 5 and 6, T. 15 S., R. 10 E., M. D., and sec. 12, T. 15 S., R. 9 E. It is on patented land held by Louis Schiochetti and George Valdez of Hollister, California. The mine was located in 1938 and the following year a few flasks of quicksilver were retorted. In 1940 it was leased to the Panoche Quicksilver Mines Company, under the direction of P. D. Burt who installed a 4 by 64-foot rotary furnace, and produced 319 flasks of quicksilver from 15,000 tons of ore, for an average of $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds of quicksilver per ton of material treated. The mine closed in January 1943 and the plant was dismantled and removed to the Guadalupe property in Santa Clara County, California.

The mine consists of about 1500 feet of workings and numerous surface prospect pits and trenches. Exploration is not deeper than 50 feet below the outcrop.

The country rock, kaolinized Franciscan sandstone and minor amounts of shale, is cut by a number of north-trending low-angle thrust faults, which have an easterly dip (see Pl. IV). These thrust faults are imbricate and split upward from the lowermost one, the silicified outcrop of which forms the bluff just above the mine. All of these faults can be readily traced over the hill by ledges of dark dense quartz which has been repeatedly brecciated, sheared, and resilicified. Many of the individual fault planes are highly polished and slickensided.

The main orebody is where one of these thrusts splits from the lower thrust; elsewhere the ore minerals invariably occur at similar splits. Greater brecciation and consequent increase in open spaces at fault-splits seem to have controlled localization of the ore.

The mine workings are between the two easternmost thrust faults where the ground is intensely broken by numerous northeast cross-fractures, most of which dip steeply to the southeast (see Pl. IV). The

orebody pitches gently to the northeast, following the plunge of the curved plane of the thrust fault, which is marked by much brecciation and recementation by silica. The ore mineral, metacinnabar, occurs in both the silicified breccia and kaolinized sandstone.

Metacinnabar is the dominant ore mineral at the Valley View mine. Cinnabar is also present, but is of no importance. Metacinnabar occurs disseminated in the sandstone as small black grains and as crystalline fillings in the silicified breccia. The grade of the ore is difficult, if not impossible, to judge by eye; consequently, accurate sorting cannot be easily done.

Cinnabar and some metacinnabar occur at several other places (see Pl. IV) on the Valley View property. All of these places are along the silicified reef which forms the brow of the Valley View hill and all are where subsidiary thrusts split upward from the lower thrust plane. Not enough prospecting has been done to evaluate these prospects, though all occur under structural conditions similar to those of the Valley View orebody.

The one exploited orebody of the Valley View mine decreased in grade at a shallow depth to such an extent that the operators could not mine it. Although there is no intrinsic reason for believing that the grade should increase with depth, there is, likewise, no apparent reason for believing it should decrease and pinch completely out. Further exploration for ore of comparable grade to that already mined should continue northeastward down the pitch of the orebody for 50 to 100 feet farther, as the grade may again improve. Surface outcrops of ore-bearing rock should at least be explored by prospect pits. Possibly drilling to the northeast of each metallized outcrop would be a practical method of exploration, although the ground is blocky. There is reason to believe that the mineralized ground extends for some distance to the east under the terrace gravels. The extension of the silicified rib could be proved, and possible splits from it could be hunted by digging trenches or by sinking shallow shafts. Geophysical methods might also be of use in mapping the structures under the alluvium.

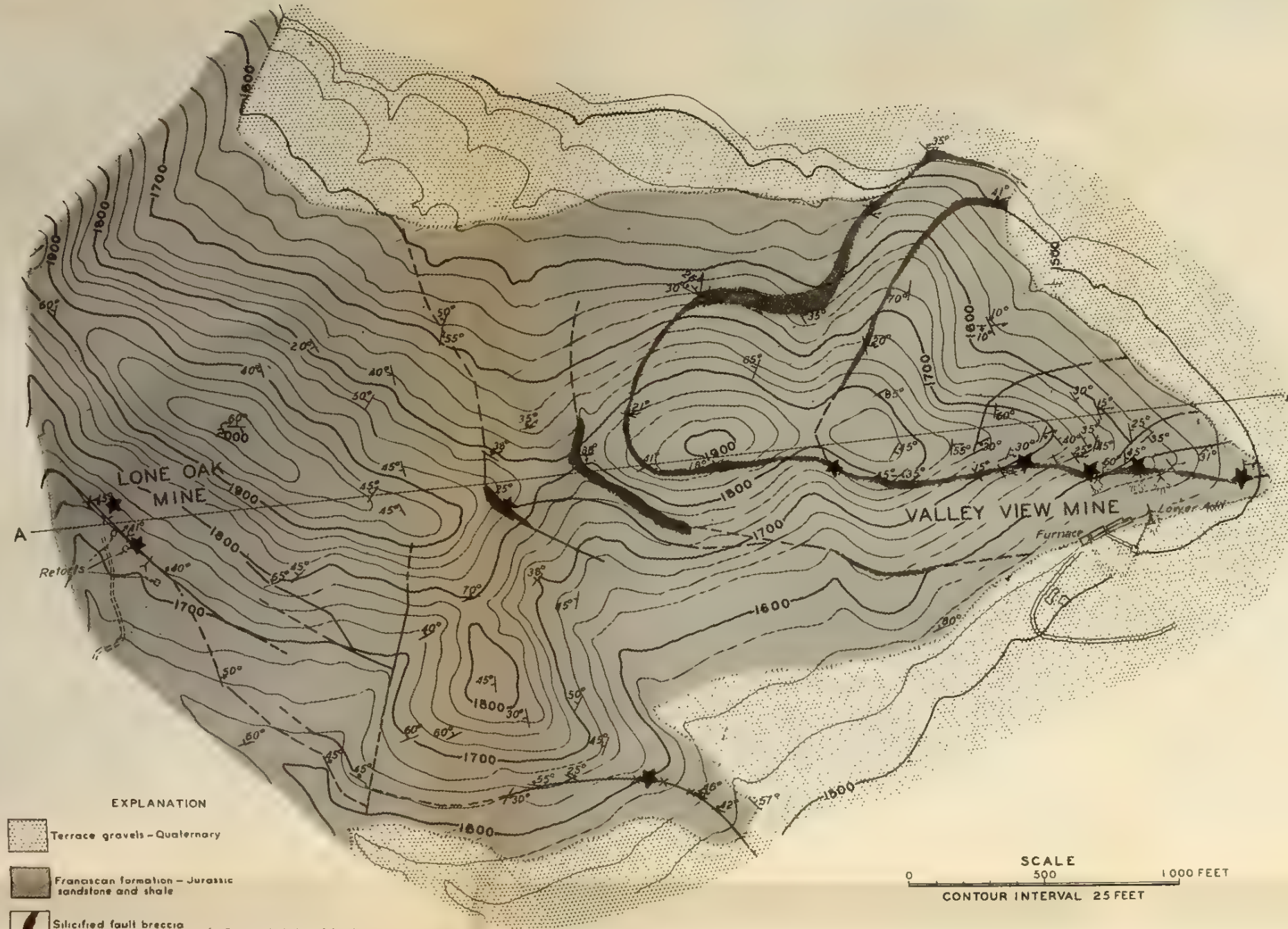
Cerro Bonito Mine

The Cerro Bonito mine is on Cerro Bonito Ridge about 2 miles south of Llanada and consists of mining claims in sec. 31, T. 15 S., R. 10 E., M.D., and in sec. 6, T. 16 S., R. 10 E. It is on patented land held by the Cerro Bonito Quicksilver Mining Company. Thomas Flint of Hollister, California, is president of the Company. During the summer of 1941 a lease on the property was held by Dan A. Williams.

This mine is one of the oldest in San Benito County, but has been inactive during most of its history. Discovered in 1873, it was operated until 1876, during which time it is reported to have produced over 800 flasks of quicksilver. This is its only recorded production. The mine was idle from 1876 until 1902 when it was taken over by the Cerro Bonito Quicksilver Mining Company who reopened some of the tunnels, most of which have since caved. In June 1941, one man was engaged in sorting the old mine dumps and retorting pieces of high-grade ore.

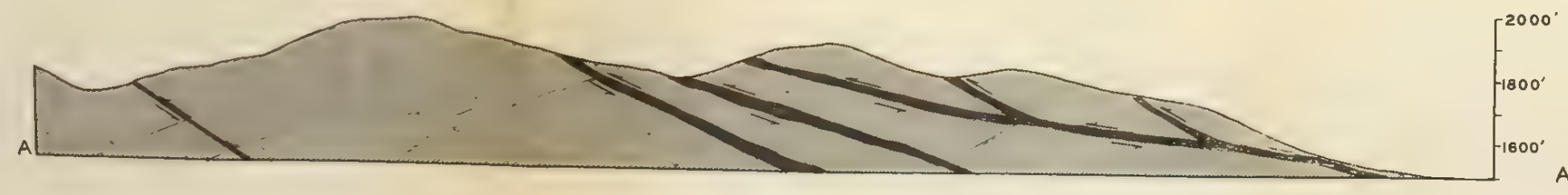
Very few of the old mine workings, which are reported to be extensive, are now accessible. Consequently, the analysis of the geology is incomplete and is based largely upon surface observations and on the

GEOLOGIC MAP
OF THE
VALLEY VIEW MINE

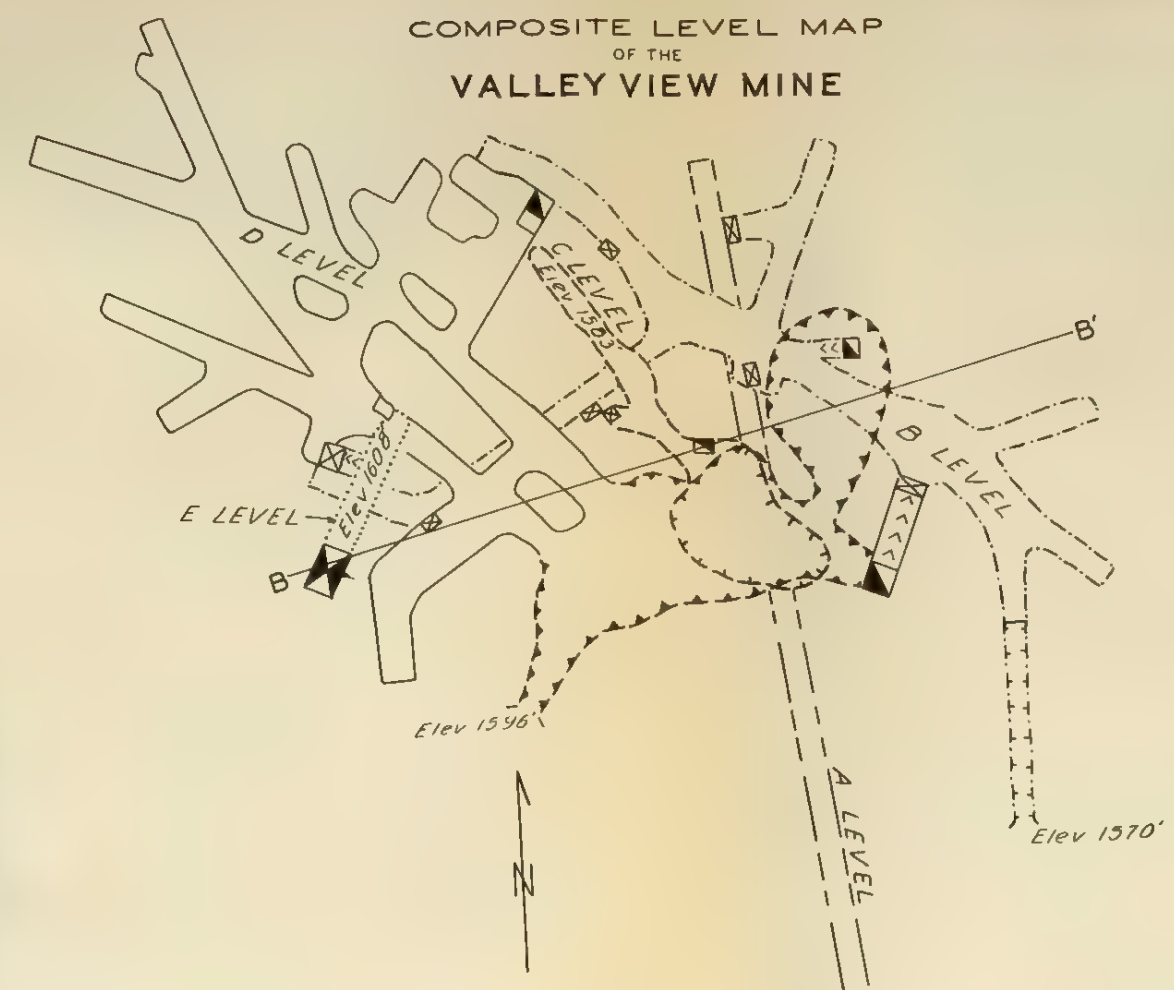


- EXPLANATION
- Terrace gravels - Quaternary
 - Franciscan formation - Jurassic sandstone and shale
 - Silicified fault breccia
 - Dip and strike of beds
 - Presence of cinnabar or metacinnabar
 - Dip and strike of fault
 - Dip and strike of fault showing direction of slickensides
 - Adit
 - Buildings etc
 - Shallow prospect pits

GEOLOGIC SECTION A-A'



COMPOSITE LEVEL MAP
OF THE
VALLEY VIEW MINE

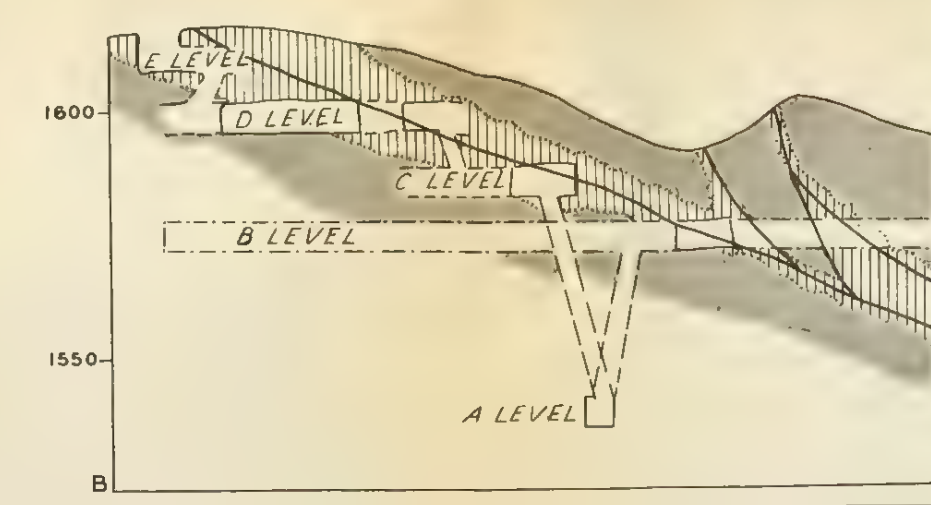


GEOLOGIC MAPS AND SECTIONS
OF THE
VALLEY VIEW MINE
SAN BENITO COUNTY, CALIFORNIA

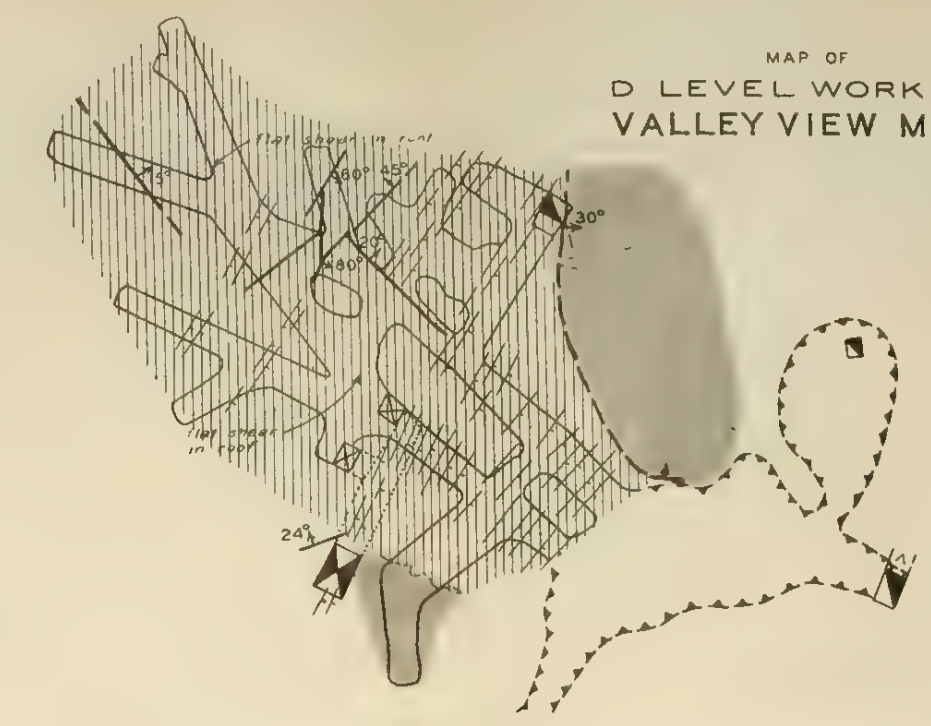
BY
R.G. YATES AND L.S. HILPERT
U.S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

JUNE 1941

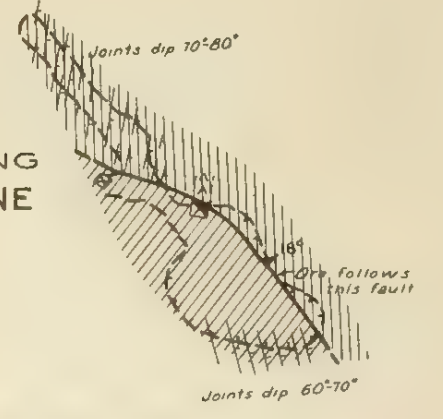
SECTION B-B'



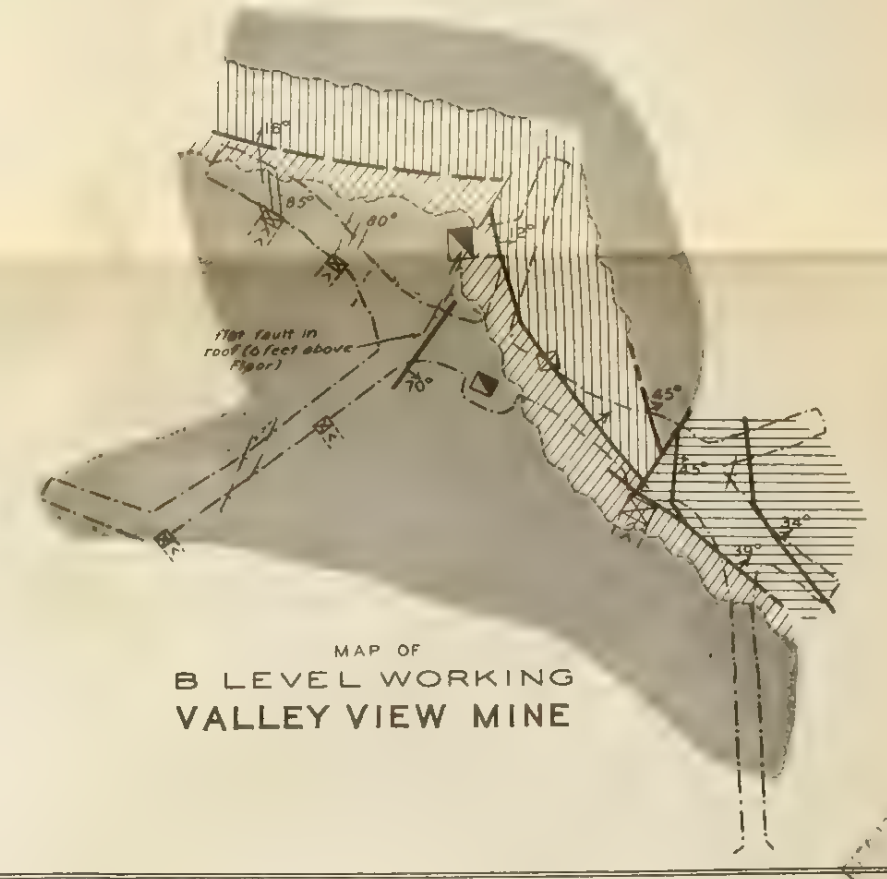
MAP OF
D LEVEL WORKING
VALLEY VIEW MINE



MAP OF
C LEVEL WORKING
VALLEY VIEW MINE



MAP OF
B LEVEL WORKING
VALLEY VIEW MINE



- EXPLANATION
- Contacts
 - Faults
 - Faults, inferred
 - Dip and strike of joints
 - Adit portal
 - Open cut, D level
 - Open cut, C level
 - Incline chevrons point down
 - Shaft
 - Raise
 - Winze
 - Kaolinized
 - Silicified and brecciated
 - Partly silicified
 - Silicified

descriptions of Forstner.⁶ The mine workings explore a thin, northward-dipping, sill-like body of serpentine, the upper part of which has been altered to silica-carbonate rock (see Pl. I). Some of the workings extend through the serpentine and into the underlying Franciscan sandstones and shales, which are separated from the serpentine in many places by a zone of black clay and crushed sandstone and shale. Cinnabar was only observed in the silica-carbonate rock, but it is reported as occurring also in the sandstone. The character of the silica-carbonate rock and its cinnabar is described in other parts of this report.

The uppermost workings are mostly surface pits and cuts in the silica-carbonate rock, which crops out on the north and west slopes of the hill. Cinnabar is widely, but erratically, distributed here and is much too pockety to permit indiscriminate mining. The lowermost adit, which is 600 feet below the surface workings on top of the hill, extends southward through the serpentine and into the underlying zone of black gouge and faulted Franciscan sediments, where it turns eastward to follow along this zone. A few hundred feet farther the adit is caved. Forstner reports, however, that this tunnel was once connected with the upper workings; also that an old adit, about 600 feet southeast of the portal of the main adit, cuts through the serpentine (here altered to silica-carbonate rock) as well as through the underlying black gouge, and extends into the sandstone, in which cinnabar was found. Orebodies of this adit were apparently not connected with those of the main adit.

It is uncertain whether further exploration is justified at the Cerro Bonito mine. The lack of exact knowledge concerning the location, extent, and character of the early workings is a decided handicap in any contemplated exploratory program. Surface showings of cinnabar are only fair, but pieces of high-grade ore on the waste dumps indicate that at least parts of the exploited orebodies were rich. The presence of cinnabar in the silica-carbonate rock and Franciscan sandstone, which underlie the serpentine sill, suggests that the lower contact of the sill had some structural control over the distribution of the orebodies; therefore, this contact should be the major place to explore.

Cerro Gordo Mine

The Cerro Gordo (also called *Bradford*) mine is on Tres Pinos Creek, about 15 miles west of Llanada and about 18 miles from the town of Tres Pinos. The property includes parts of secs. 3, 4, and 9, T. 15 S., R. 8 E., M. D. Little time was spent in examining this mine, which is almost completely caved and has no recorded production. Dan A. Williams held a lease on the property in the summer of 1941, but had not reopened any of the old workings. At least 1000 feet of workings are in the mine, which consists mainly of a 200-foot inclined shaft, connected at its bottom by an adit. The property includes an old brick coarse-ore furnace which has never been in operation.

The mine workings are in silica-carbonate rock and gougy Franciscan fault breccia which separates Franciscan rocks on the northeast from Cretaceous sandstones and shales on the southwest. The breccia trends northwestward and dips to the northeast. The silica-carbonate rock is only 16 feet thick in the mine, and strikes northwest and dips 60° NE.

⁶ Forstner, William, op. cit., pp. 134-137.

The inclined shaft was sunk along the footwall of this silica-carbonate rock, which carries some cinnabar, as shown by material on the dumps; but according to old reports no workable orebodies were ever found. Pyrite, metacinnabar, and hydrocarbons are associated with the cinnabar.

Bitter Water Mine

The Bitter Water mine is on Bitter Water Creek about 2 miles southwest of Llanada, in sec. 25, T. 15 S., R. 9 E., M. D. (see Pl. I). It is owned by H. V. Underwood and E. A. Matthews of Hollister, California. This mine produced a few flasks of quicksilver in 1932 and 1938, but since then has been inactive. The mine workings (less than 100 feet in length) are in Panoche sandstone and the only stope follows a fracture complementary to the northeast fault along Bitterwater Creek. No cinnabar was observed, but it was probably present as fracture fillings and as impregnations in the sandstone.

Lone Oak Mine

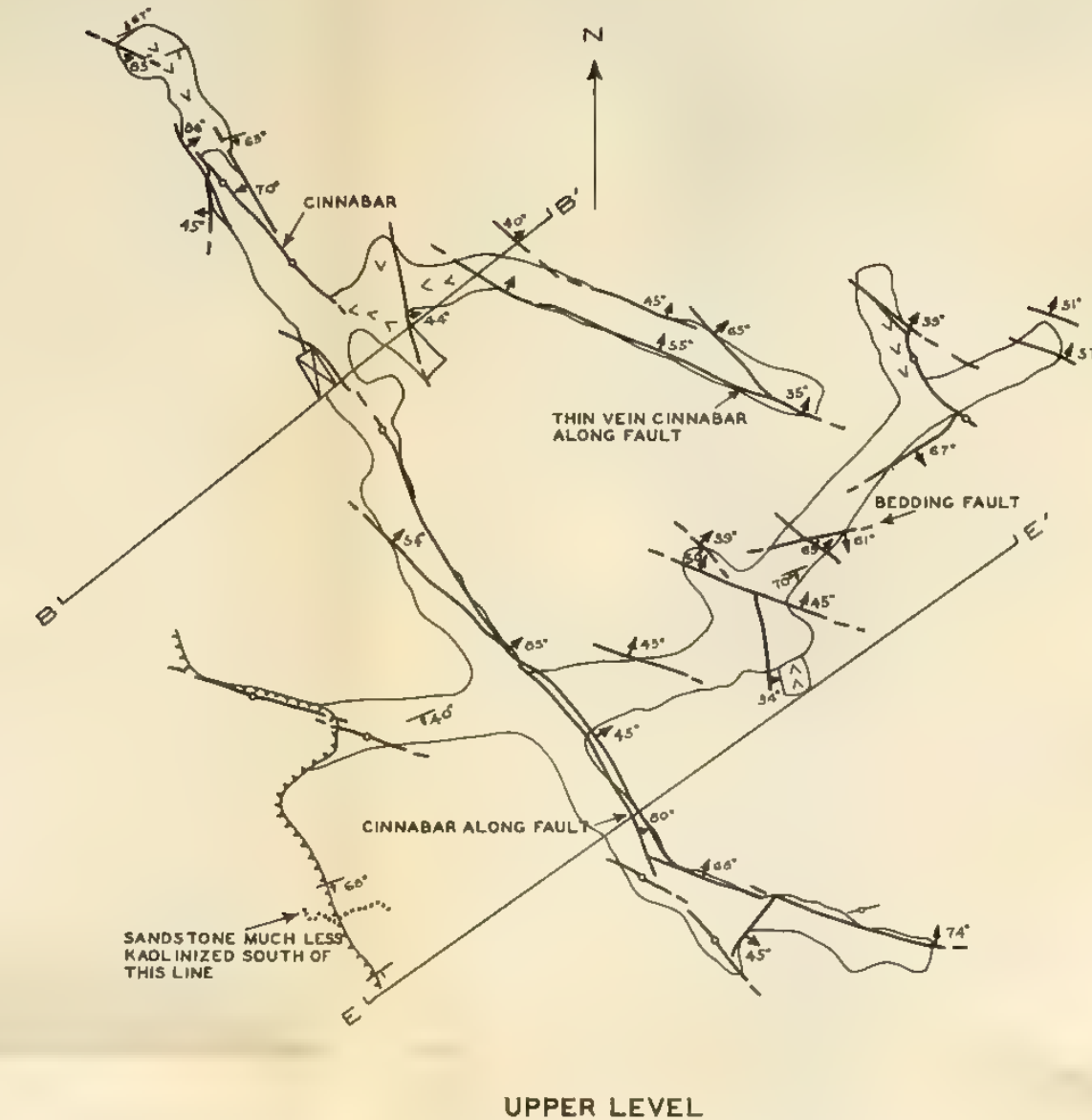
The Lone Oak mine is about half a mile west of the Valley View mine (see Pl. IV), in sec. 7, T. 15 S., R. 10 E., M. D. It is on land owned by Mrs. Frank McCollough of Hollister, and in 1941 was under lease to Morris E. Turner and Andrew Balderama. The workings are not extensive and consist mainly of surface pits and trenches scattered over a length of approximately 400 feet. The ore is retorted on the property and about 50 flasks of quicksilver have been produced.

The country rock is Franciscan sandstone and the ore occurs as pockets and thin stringers of cinnabar along a silicified low-angle thrust fault that trends northwest and dips 30° to 70° E.

Lucky Strike Mine

The Lucky Strike mine is half a mile northwest of the Lone Oak mine, in sec. 12, T. 15 S., R. 9 E., M. D. It consists of two claims held by Louis Sciochetti, George Valdez, and R. Tellerina, and is on land owned by Mrs. Rose H. Garcia. The deposit was discovered in 1940 by Louis Sciochetti and was leased about July 1941 to James E., George W., and Claude E. McIntyre of Hollister, California. When first visited in May 1941, only shallow prospect pits were on the property, but when revisited in December of that year there were several hundred feet of underground workings and the deposit had been explored to a depth of over 50 feet. The mine was again visited and mapped in March 1944, at which time it was inactive. The workings at that time totalled about 1200 feet in length and had a vertical extent of about 130 feet, in a block of ground about 200 feet square. Two retorts, comprising 6 tubes, were on the property in March 1944. Total production to 1944 was between 200 and 300 flasks, all of which was produced by the McIntyres prior to termination of their lease in 1942.

The Lucky Strike is on the same thrust fault as the Lone Oak mine, but at the Lucky Strike the fault is marked by a zone of en echelon shears which strike about N. 30° W. and dip from vertical to about 45° NE. (See Pl. V). These shears have undergone only a small amount of movement. The displacement of beds alone is a poor criterion for supporting this conclusion, because the grooving of the shears has the same general pitch as the dip of the bedding. However, many other facts support the



GEOLOGIC MAPS AND SECTIONS
OF THE
LUCKY STRIKE MINE
SAN BENITO COUNTY
CALIFORNIA

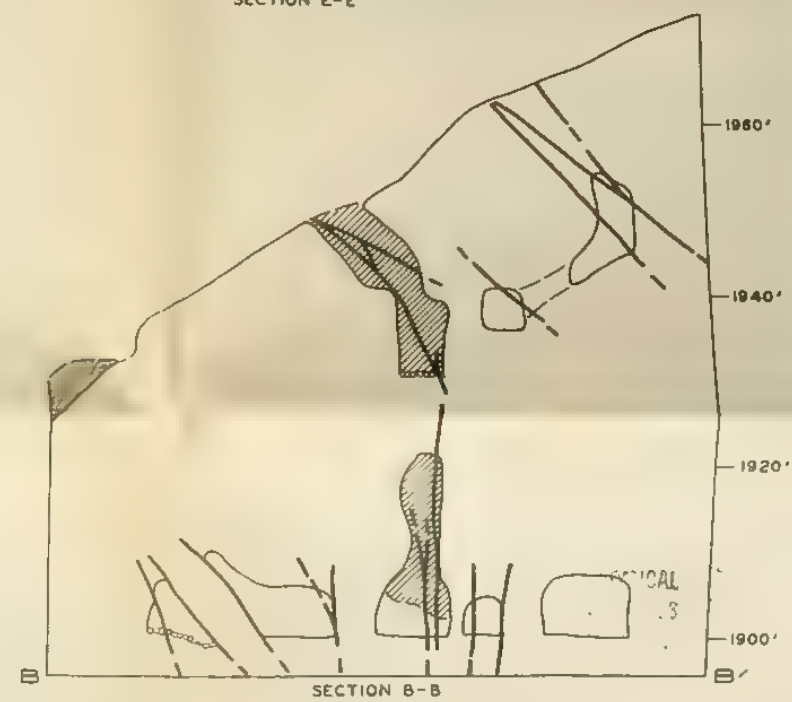
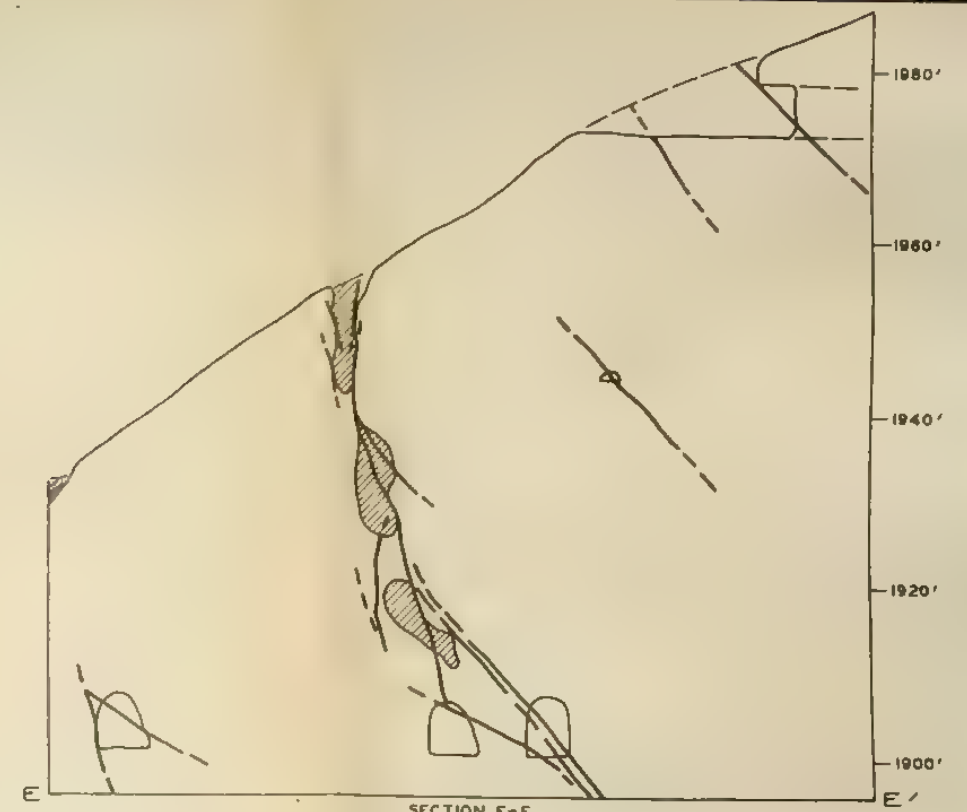
SCALE
0 20 40 FT

GEOLOGY BY L. S. MILPERT AND G. D. EBERLEIN
U.S. GEOLOGICAL SURVEY
MARCH 1944

LEGEND

- STRIKE AND DIP OF BEDDING
- VERTICAL BEDDING
- GRADATIONAL CONTACT
- FAULT (SHOWING DIP ON FAULT PLANE)
- VERTICAL FAULT
- PROBABLE OR INFERRED FAULT
- INC. LINE (CHEVRONS POINT DOWN SLOPE)
- RAZE
- WINZE
- STOPE
- SURFACE OPENING

ALL MINE WORKINGS ARE IN KAOLINIZED SANDSTONE
UNLESS OTHERWISE NOTED





belief that the movement has been small. The offset of intersecting shears seldom exceeds a few inches, the horizontal and vertical extent of individual shears is usually less than 50 feet, and the strongest shears do not exceed 100 feet. Only along the stronger ones is any appreciable amount of gouge or breccia developed.

The orebodies occur along the strongest shears, which are nearly vertical, and are marked by thin gouge zones both along the shears and at the numerous intersections where minor shears split from them. These gouge zones range from a fraction of an inch to several inches in thickness. Cinnabar impregnates both the gouge and narrow margins of the wall rock where it formed high-grade veins, which locally contained as much as 50 percent quicksilver. Cinnabar also occurs along many of the weaker shears, but there it usually occurs as finely crystalline incrustations too narrow to mine economically. The sandstone and lesser amounts of shale about the mine are highly kaolinized and are on the zone of altered sandstone that extends along the faults from the Valley View mine past the Yturriarte mine (see Pl. I).

In March 1944 little ore was in sight, but some unexplored ground remained. Possibly more ore-bearing shears lie east and west of the present workings, and a moderate amount of ore may exist for a short distance below the lower level along the north extension of the easternmost vein. Prospecting should be guided by the fact that the main fault zone strikes nearly eastward and dips from 30° to 45° N.

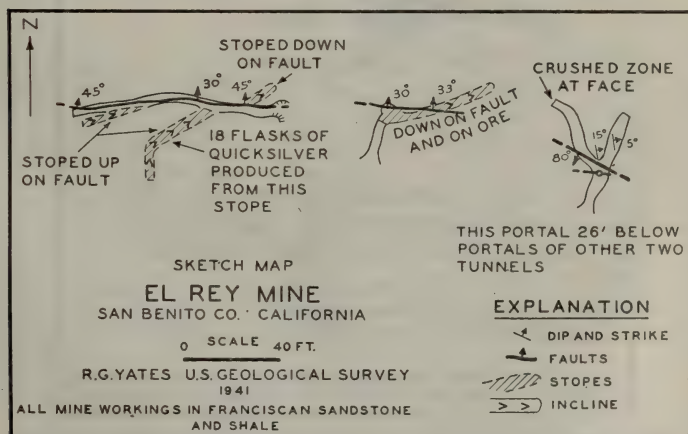


FIG. 2. Sketch map of El Rey mine, San Benito County, California. All mine workings in Franciscan sandstone and shale.

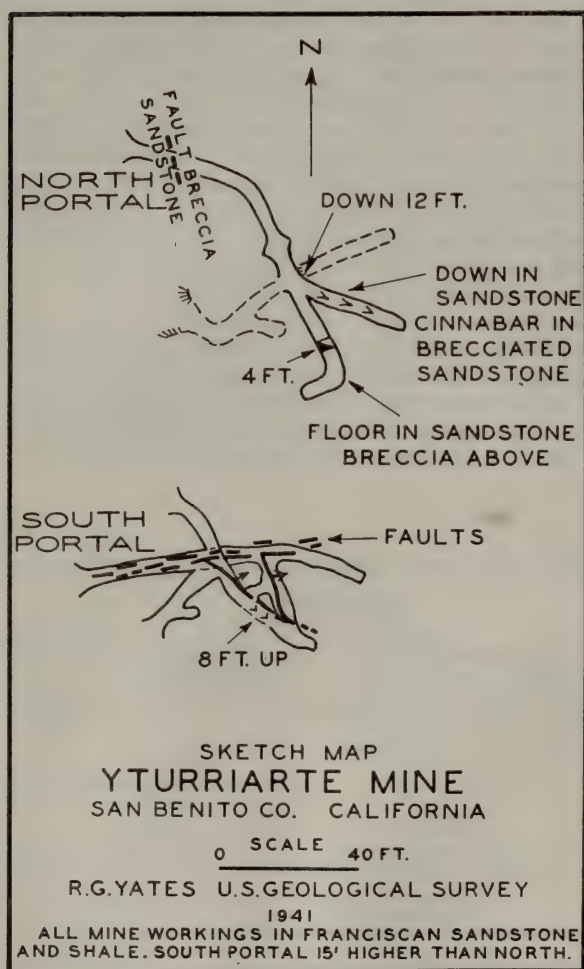


FIG. 3. Sketch map of Yturriarte mine, San Benito County, California. South portal 15 feet higher than North portal. All mine workings in Franciscan sandstone and shale.

El Rey Mine

El Rey mine is a quarter of a mile northwest of the Lucky Strike mine, in sec. 12, T. 15 S. R. 9 E., M. D. It was discovered in 1940, and by 1943 had produced about 60 flasks of quicksilver. In March 1944 only prospecting was being done. A small 2-pipe retort is on the property. The mine is owned by Manuel Perry and in 1941 was under lease to Dan A. Williams and Juan Quinonez. At that time the principal workings, which are shown in figure 2, totaled about 300 feet in length.

The mine is on the same fault as the Lone Oak and Lucky Strike mines, and the geology of the deposit is essentially the same. At El Rey mine the fault has a general eastward strike and dips from 30° to 45° N. There is more brecciation of rock along the fault here than at the Lucky Strike.

Yturriarte Mine

The Yturriarte property lies, immediately northwest of El Rey mine, in sec. 12, T. 15 S., R. 9 E., M. D. It is owned by Mrs. Frank McCollough and in 1941 was leased to Roy Gilbert. In 1944 it was idle. Since its discovery in April, 1940, it has produced 18 flasks of quicksilver, which was roasted in a small retort on the property. Figure 3 shows the extent of the workings, which total about 400 feet in length. Although the Yturriarte deposit is on the same fault zone as the Lucky Strike and El Rey it differs from them by being in a wide breccia zone of Franciscan sandstone and shale. The cinnabar is found in the shaly breccia matrix and in and along the boundaries of sandstone blocks within the breccia.

Parker-Carlson Mine

The Parker-Carlson mine, discovered in 1941, is 2 miles northwest of Llanada in sec. 13, T. 15 S., R. 9 E., M. D. (see Pl. I). The property is owned by Mrs. Frank McCollough and in 1941 was leased by G. B. Parker and G. E. Carlson of Hollister, California. The country rock is Franciscan sandstone. Cinnabar is found along a north-trending thrust fault which dips about 30° E. The thrust fault is marked by a thin rib of silicified and slickensided fault breccia. The ore occurs in this breccia and in immediately adjacent kaolinized sandstone. Only small pockets of ore have been mined from the workings, which are small and shallow. When the property was examined there was no ore in sight. Several flasks of quicksilver have been recovered with a small retort.

WAR-TIME MINERAL INDUSTRY OF CALIFORNIA *

By SPANGLER RICKER**

UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF MINES

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INTRODUCTION

According to recent statistics compiled by the Federal Bureau of Mines, California was third in the United States and Alaska in production of mineral commodities for the year 1943. The value of the production was \$569,386,000. This is an increase of \$101,773,000 over the value of the 1939 production, notwithstanding the fact that gold production decreased in value from \$50,234,000 to \$5,191,000 during this period.

The production for 1943 was listed by the Bureau of Mines under three headings: fuels, \$447,984,000; nonmetallic minerals, \$88,293,000; and metallic minerals, \$33,109,000. The State held second place in production of fuels and second place in the production of sand and gravel, diatomite, sodium carbonate, and sodium sulphate and boron minerals in the nonmetallic group.

In the metallic-mineral group, California held first place in production of chromite and mercury and second place in tungsten and manganese ore production. These were four of seven metals (antimony, chromium, nickel, manganese, mercury, tin, and tungsten) that were designated as strategic in 1939 by the Secretaries of War, Navy, and Interior, upon advice of the Army and Navy Munitions Board. Later, other minerals, such as lead, copper, zinc, aluminum, magnesium, and quartz crystal, were added to the strategic-mineral list.

It is the metallic-mineral group to which the body of this article refers, as it was with this group that the work of the California District of the Federal Bureau of Mines was chiefly concerned.

The production of the fuel and nonmetallic minerals was mainly dependent upon manpower and equipment, and was to a great extent from a supply of raw materials known to be plentiful.

The necessity of increasing production of the metallies placed a heavy drain on the known ore reserves of many of the minerals. During

* Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior. Manuscript submitted for publication December 22, 1944.

** District Engineer, Western Region, Bureau of Mines, San Francisco, California.

the period since enactment of the Strategic Minerals Act (Public No. 117—76th Congress, Chapter 190, 1st Session), more than 500 mining properties were investigated in the State of California alone by the Federal Bureau of Mines, to determine if exploration work by the Bureau was warranted. Project work, consisting of surface trenching, diamond drilling, sampling, and underground development, was completed on 31 properties. In addition, more than 150 mines and prospects were investigated to determine whether or not expenditure of Federal funds for access road construction would be justified.

During the last fiscal year (1944), production from mining properties on which the Bureau of Mines has done project work which directly or indirectly aided the operators was approximately as follows:

Quicksilver -----	16,000	flasks
Copper -----	5,000,000	pounds
Tungsten -----	8,000	units WO ₃
Chromite -----	40,000	tons ore and concentrates

Considerable tonnages of iron and manganese ores and alumina clays have also been developed.

An approximate summary of production for the same fiscal year from properties to which access-road work has been completed is as follows:

Quicksilver -----	3,500	flasks
Copper -----	20,000,000	pounds
Zinc -----	7,000,000	pounds
Tungsten -----	4,000	units WO ₃
Chromite -----	22,000	tons ore and concentrates

In addition there has been an appreciable production of manganese ore and barite.

Many new metallurgical plants using raw materials were established during the war period, and capacities and metallurgical processes were increased and improved in other older plants. Experimental work in metallurgy was continually carried on by the Bureau of Mines to develop new or improve old processes.

Production figures used in this report are taken principally from the Mineral Production and Economics Division of the Federal Bureau of Mines, and the California State Division of Mines. Sometimes only preliminary figures and at other times approximations were used, and the figures should not be employed for definite statistical production as they were compiled to serve the general purpose of this report only.

ALUMINUM

Two aluminum plants were erected by the Defense Plant Corporation. These were operated by the Aluminum Corporation of America and situated at Los Angeles and Riverbank. They contain 5 and 3 pot lines respectively, and obtained alumina from the Middle and Southern States. The combined capacity is reported to be 256,000,000 pounds of aluminum per year. Whether or not these plants can operate commercially in the immediate postwar period is questionable.

The Bureau of Mines has investigated alumina-bearing clay deposits of the State, and as a result has developed a total of 50,000,000 tons of

clay with an average content of 23.7 percent of available alumina per ton. Metallurgical experimentation is also being carried on to find a process of alumina extraction that could be used in case of a shortage of bauxite ores, which have been the only source of alumina used in aluminum production to date. This experimental work has definitely established that alumina can be produced in commercial quantities, but the cost of production cannot compete thus far with the alumina produced from bauxite.

CHROMITE

The production of massive chromite ore and concentrates increased from around 3,500 tons in 1939 to 46,355 tons in 1943. Because of the closing of the Rustless Mining Corporation property in Glenn County, the production is expected to be somewhat less in 1944. Although some of the better-known ore reserves have been practically depleted, it is believed that under favorable prices, California could produce suitable concentrates for many years.

Concentrates were produced principally from the Castro mine, San Luis Obispo County, and the Grey Eagle mine, Glenn County, and concentrating plants of 125- and 200-ton capacity, respectively, were erected.

A major part of the massive high-grade ore was produced from Siskiyou, Del Norte, Tehama, Humboldt, and Placer Counties.

Exploration projects which aided in the development of ore reserves were concluded by the Federal Bureau of Mines on the Castro, Grey Eagle, Seiad Creek, McGuffy Creek, Sweetwater, McCormick, and French Hill mines. Access roads to aid transportation were recommended and constructed to several others.

COPPER

The preliminary estimate of copper production for 1943 was 17,950,000 pounds. For 1944, the production will approach, and may exceed, 30,000,000 pounds. This will more than triple the amount produced in 1939, which was reported in the Mineral Yearbook of that year as 8,360,000 pounds.

This increase in production came chiefly from the well-known ore reserves at the Grey Eagle mine, Siskiyou County; Keystone mine, Calaveras County; Hornet mine, Shasta County; and Newton mine, Amador County. At the present rate of production it is reasonable to expect that the known copper-ore reserves in a number of the properties will be greatly depleted after the war. There are no data available that indicate important new discoveries or developments.

Geological and mining examinations in some of the older districts, such as those of Plumas and Shasta Counties, would be well justified if California is to be an important producer of copper in some future emergency.

The Bureau of Mines diamond drilled both the Keystone and Newton mines as a direct aid to the operators, and recommended and constructed access roads to the Grey Eagle and Hornet mines.

Unwatering of the Penn mine, Calaveras County, was completed to the lower level in No. 2 shaft toward the end of 1944, and an appreciable production of copper can now be expected from this old property.

The ore will be treated in the Eagle-Shawmut gold mill, which has been remodeled for dressing this type of copper ore.

Among the important metallurgical plants erected during this recent period are the 700-ton flotation plant at the Grey Eagle mine, and a similar plant of about 300-ton capacity at the Hornet mine. A plant to treat the old Union mine tailings was erected in Calaveras County.

IRON

Owing to the erection of the blast furnace and steel plant at Fontana, San Bernardino County, and the use of magnetite for ballast in ship construction, the production of iron ore increased from approximately 17,000 tons in 1939 to more than 900,000 tons in 1943. This increase in production came chiefly from the Kaiser Company, Inc., Vulecan mine, which furnishes iron ore for one blast furnace at Fontana. The furnace, completed in 1942, has a producing capacity of approximately 432,000 tons of pig iron per year.

The other important operators were the Shasta Iron Company and the Nevada Santa Cruz Company, both of which produced magnetite only for ship ballast, the latter obtaining its product from the Pacific Ocean beach sands.

More than 100 iron occurrences were examined by the Bureau of Mines, and from these the following properties were selected for project work: the Eagle Mountain, Iron Mountain, and Bessemer properties in San Bernardino County; and the Shasta Iron Company property in Shasta County. Results of the project work are as follows:

	<i>Tons</i>
Measured ore.....	22,858,000
Indicated ore.....	17,360,000
Inferred ore.....	44,321,000
Total.....	84,539,000

Approximately 15,000,000 tons of the inferred ore would require concentration to make 50-percent grade.

Access roads to the Bessemer and Iron Mountain deposits were approved by the Bureau, and construction was completed in 1944, enabling the shipment of a few thousand tons of magnetite for ship ballast.

Metallurgical tests were made on samples from all properties on which project work was undertaken.

LEAD

Production of lead also increased appreciably as a result of war demands. The total production in 1939 was slightly over 1,000,000 pounds, whereas in 1943 the production was over 10,000,000 pounds. This came mostly from southern California, and while it naturally depleted reserves, under high prices and war-time necessity, additional prospecting and development can be expected to maintain the increased output.

MANGANESE

Although practically no manganese ore was produced in California in 1939, the State has held second place in production during the war period thus far. Most of the ore ranged from 35 to less than 50 percent manganese and was sent from numerous small properties scattered over the State to Government stock piles.

Of the 13 Government stock piles for purchase of small lots of manganese and chromite ores, 7 are located in California.

Over 15,000 tons of ore was produced in 1943, of which a major part came from Stanislaus, Plumas, and Trinity Counties. It is expected that, as a result of the termination of some Government contracts and the changed specifications for ore purchased, the total production will decrease somewhat during 1944. A manganese ore-dressing plant was erected by the General Dry Battery Company near Patterson, Stanislaus County, but the plant ceased operation in 1944 after a small production of high grade concentrates.

Many mines and prospects were examined by the engineers of the Bureau of Mines during this period. The most noteworthy exploration project was at the Ladd mine and vicinity, where over 230,000 tons of ore with a manganese content of 18 percent was indicated. Shipments of this ore have been made to the Bureau's experimental plant at Boulder City, Nevada, for testing purposes. Previously, the Bureau had done considerable work for a company in Oakland, California, that had been interested in the erection of an electrolytic manganese plant. Because the demand for manganese for the war program is no longer so great, this plant has never been constructed.

MAGNESIUM

California was very active during the war period in the production of magnesium. A plant was erected at Permanente by the Permanente Metals Corporation to produce magnesium by a modification of the original Hansgirg process. Sea-water magnesia was obtained from the Westvaco Chlorine Products Company and later from its own plant at Moss Landing. The Permanente Metals Corporation also erected a plant using the ferrosilicon (Pidgeon) process, at Manteca.

The demand for magnesium has decreased considerably, and the future of the magnesium industry in the State is not encouraging at this time. It depends not on the supply of raw materials but on the consumption of the metal. Numerous magnesite and dolomite deposits have been examined by the Bureau of Mines during the past few years.

MOLYBDENUM

Molybdenum occurs as an accessory mineral in the tungsten mines of the U. S. Vanadium Corporation at Pine Creek, Inyo County, California. Owing to their increased operation during this war period, California has taken fourth place in production of this metal. Total quantity produced in 1943 was over 900,000 pounds. The operations have been decreased appreciably during 1944, so that 1943 is probably the peak production year to date.

QUICKSILVER

According to records maintained by the State Division of Mines, California quicksilver production rose from 11,201 flasks in 1939 to 33,948 flasks in 1943. This rise was due to increased war demands and the consequent increased prices. California easily took first place among the States and in 1943 produced over 60 percent of the total.

The greater part of output came from the western counties from Santa Barbara north to and including Lake County. A minor portion came from Trinity County. The largest producer was the New Idria mine, in San Benito County.

This increase has depleted the potential reserves. On the other hand, quicksilver ores seldom are blocked out in advance, and it is thought that price increases at any future time that will justify exploration and prospecting will bring out an ample supply to meet future emergencies.

Access roads were built on recommendation by the Bureau of Mines to several properties, and project work was carried out on the Coso Springs area, Inyo County; New Idria, San Benito County; Guadalupe and New Almaden, Santa Clara County; and the Oat Hill mine, Napa County. Appreciable tonnages of low-grade reserves were indicated at the Coso Springs, Guadalupe, and Oat Hill districts, and information that assisted the operators was obtained at the New Idria and New Almaden mines.

TUNGSTEN

California was one of the three foremost producers of tungsten ore in the United States during the war period. Production rose, according to State Division of Mines records, from over 74,000 units of WO_3 in 1939 to more than 254,118 units in 1943. The production probably will be appreciably less in 1944, owing to surplus in stockpiles and cancellation of contracts by the Metals Reserve Company.

Tungsten ores, mostly scheelite, occur in most of the southeastern counties from Mono to San Diego. The principal producer in the State has been the U. S. Vanadium Corporation, which operates the mines and beneficiation plant at Pine Creek, Inyo County. Many other properties produced substantial quantities of ore and concentrates, and new discoveries and development were on the increase at the time contracts were being canceled.

The largest concentration and chemical plant (1,300-ton capacity) was erected at Pine Creek during this period; and an aerial tramway, 11,800 feet in length and having a capacity of 100 tons in 8 hours, was erected at the Tungstar mine in the same district. Many smaller plants were erected in the other producing counties, and with high enough prices the production of required quantities of tungsten could be maintained in California for many years.

The Bureau of Mines carried on active projects at the Black Rock, Atolia, and Darwin mines while increased production was vital to the war. Access roads were recommended and built to properties.

ZINC

Zinc production increased from 12,000 pounds in 1939 to 2,568,000 pounds in 1943 and is expected to be about 15,000,000 pounds in 1944.

The increase in 1944 is due to the operations that have been carried out by the Red Cloud Mines, Inc., on the Blue Moon mine in Mariposa County. The Big Bend mine in Butte County and the Hornet mine in Shasta County were the other important producers.

Since the unwatering of the Penn mine in Calaveras County, the increased production of the State can be maintained for some time from the known ore reserves. Most of the past production, as well as the increased production, is from ore reserves that had been indicated before the war period. This increase is a great drain on zinc resources of the State, and additional exploration and geological studies would be necessary to develop reserves so that post-war or future emergency production could be maintained.

Access roads were constructed on recommendation of the Bureau of Mines to the Big Bend, Hornet, and Blue Moon properties. Several exploration projects were concluded on several mines, but only limited reserves were developed.

POSTWAR PERIOD

The increased mineral production of the State was in major part due to increased consumption of mineral commodities for the war plants. In spite of an increase of more than 1,000,000 in the population of California since 1940, there was an acute shortage of labor from time to time at numerous mining properties.

After the war, a decreased demand for many of the mineral products can be expected. This can be noted already in the curtailment of production at the tungsten, quicksilver, chromite, and manganese mines and the lack of interest in exploration for new prospects of those metals.

The iron and steel, aluminum, and magnesium industries, which have been established during the past few years, will be on a purely competitive basis with industries of the other states in the post-war period. New, lower-cost processes must be sought so that all of these plants can continue at as high a production as possible in line with demand for products. Long-range local and export markets must be developed in order that these new industries may survive.

Rehabilitation and reopening of the gold mines will counterbalance to some extent the decrease in activities of the other metal mines.

California has contributed an appreciable quantity of minerals for the war. The proper agencies should continue investigations to endeavor to replenish the greatly depleted ore reserves of certain minerals so that in case of another emergency period, the future production of the strategic minerals can again be maintained. In this respect the Bureau of Mines is now planning to erect a steel-alloy pilot plant at Shasta Dam. This plant will use material processed from raw-mineral resources of the State. A quicksilver project is now being carried on to develop a large tonnage of low-grade marginal ore that could immediately be put into operation should the quicksilver shortage again become acute. It would seem that the objectives of the various Government agencies should be directed in the post-war period along the following lines:

1. Continuation to a limited extent of the work now being done in an endeavor to increase ore reserves of certain minerals that have been depleted by the war.

2. Study and exploration to gain detailed knowledge of individual deposits and of nearby sources of complementary raw materials, such as fuel, electric power, or deposits of other minerals, so that lower-grade deposits than those to which we have been accustomed might be fully utilized in the future.

3. Laboratory and pilot-plant studies to determine the most advantageous method of treating the ores of the individual deposits. For instance, it might be possible to combine the advantages of the Central Valley power and natural gas, developed and undeveloped, with high-grade magnetite deposits which the Bureau of Mines is at present endeavoring to develop in the area, and the known chrome and manganese deposits on which considerable work has already been done, to work out an alloy-steel industry in northern California. Consideration along the same lines should possibly be given to more pilot-plant studies as to the possibility of producing aluminum from California clays.

4. A study to show how the present pattern of use of mineral products can be adjusted to the mineral deposits that are already known and developed.

MINERAL EXHIBIT AND STATISTICS

ACCESSIONS TO THE EXHIBIT

By HENRY H. SYMONS *

The museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of economic and academic value. It ranks among the first five such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

The exhibit is daily visited by service men, engineers, students, business men, and prospectors as well as tourists and sightseers. In addition to its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the Division of Mines, as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the exhibit are the following:

- 21175 GOLD, native, and PETZITE, in quartz, from Carson Hill mine, Calaveras County, California. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 704.
- 21176 CALCITE, CaCO_3 , in tabular crystals, one of optical quality. From Indio, Imperial County, California. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 120.
- 21177 CALCITE, CaCO_3 , of optical quality, from Clyde Park district, near Livingston, Montana. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 120.
- 21178 ZEOLITE on CALCITE, from Clyde Park district, near Livingston, Montana. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 242.
- 21179 SCHEELITE, CaWO_4 , from Dorothy Lake, Yosemite National Park, California. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 238.
- 21180 GOLD ore (high grade), filled with very fine native gold from United Eastern mine, Mohave County, Arizona. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 704.
- 21181 SILVER, native (Ag), from Nevada Wonder mine, Churchill County, Nevada. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944. In case 310.
- 21182 IODOBROMITE ($2\text{AgCl} \cdot 2\text{AgBr} \cdot \text{AgI}$), from Wonder, Churchill County, Nevada. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944.
- 21183 IODYRITE (AgI), from Wonder, Churchill County, Nevada. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944.
- 21184 IODYRITE (AgI), from Tonopah, Nye County, Nevada. Donated by John A. Burgess, 6016 Manchester Drive, Oakland, California, October 30, 1944.
- 21185 Brecciated banded AGATE which has been re-cemented. Found 6 miles northeast of Yermo, San Bernardino County, California. Donated by E. H. Peebles, San Gabriel, California. In case 225.
- 21186 GOLD ore (high grade) from Tavua Goldfields, Fiji Islands. Donated by Pat Costello, The Block, Suva, Fiji. In case 704.
- 21187 GOLD TELLURIDES in andesite, from Tavua Goldfields, Fiji Islands. Donated by Pat Costello, The Block, Suva, Fiji. In case 704.

* Statistician and Curator, Division of Mines.

REVIEW OF CALIFORNIA MINERAL PRODUCTION FOR 1944

By HENRY H. SYMONS *

The total value of the mineral production of California for the year 1944 is conservatively estimated to be \$451,553,000. This is partly detailed in the tabulation below, but there are more than sixty mineral substances on California's commercial list. Figures on the most important items only are available at this early date. The production report forms are being mailed to the operators in all mineral lines and the detailed and completed report will be compiled and published later.

The estimated total of \$451,553,000 is an increase of approximately \$25,108,000 over the 1943 total value of \$426,445,280. The above total value for 1944 is the largest annual mineral output on record and is due to increased petroleum and natural gas yields.

The total petroleum output showed an increase of about 26,846,000 barrels or about 9.5 percent in amount, with about a 10.5 percent increase in value over 1943. The estimated quantity of crude oil is 310,992,000 barrels for the year and is the largest annual amount ever produced in California, although its value was exceeded by that of 1926 when the unit value per barrel was much higher. Natural gas showed an increase of about 12.5 percent in both amount and value of that utilized, compared with the previous year.

Reports of the Mint and smelters show the output of gold to be the smallest of any year since 1848, the year of James W. Marshall's finding of gold at Sutter's Mill. Metals that showed an increase in output were copper, iron ore, and zinc. All other metals registered a decreased output due to lesser war demand, and to the fact that reserves in stock piles had become adequate, resulting in lower prices and cancellation of contracts and bonuses. The value of the output of copper, chromite, iron ore, quicksilver, tungsten ore, and zinc, as well as that of gold, exceeded the million-dollar mark.

Of the structural materials, a lower total value will be registered by all major mineral substances in this group including cement, miscellaneous stone, brick and hollow building tile, etc. Under the miscellaneous industrial group there will be many increases and decreases in total outputs, owing to varying demands on the group as a whole, showing a slight increase in total value. The saline group as a whole showed an increase in total value.

* Statistician and Curator, Division of Mines.

Estimated values and quantities for 1944 are as follows:

\$3,972,000	(113,500 fine ozs.) gold.
543,000	(763,700 fine ozs.) silver.
3,236,000	(24,150,000 lbs.) copper.
875,000	(11,076,000 lbs.) lead.
1,766,000	(15,767,000 lbs.) zinc.
2,716,000	(24,250 flasks) quicksilver.
10,825,000	other metals including chromite, iron ore, manganese ore, molybdenum ore, platinum group metals, and tungsten ore.
323,432,000	(310,992,000 bbls.) petroleum.
31,468,000	(499,500,000 M.cu.ft.) natural gas.
22,505,000	(14,970,000 bbls.) cement.
18,500,000	miscellaneous stone.
3,900,000	brick and hollow building tile.
915,000	other structural materials, including granite, magnesite, marble, sandstone, and slate.
10,700,000	miscellaneous industrial materials.
16,200,000	salines including borates, potash, iodine, salt, soda, and others.
\$451,553,000	total.

LABORATORY

ADDITIONS TO BULLETIN 113

By GEORGE L. GARY *

- No. 136 The name hectorite is proposed for the magnesian bentonite from Hector, San Bernardino County. It is regarded as being the magnesium end-member of the montmorillonite group. The American Mineralogist, Jan.-Feb. 1944, p. 73.
- No. 137 Acicular crystals of rutile in quartz have been reported from Laytonville, Mendocino County.
- No. 138 Analcite crystals in rhyolite were reported from Pleasant Valley in Alpine County.
- No. 139 Stilbite crystals were found in rhyolite on Ebbetts Pass in Alpine County.
- No. 140 Vivianite, a hydrous ferrous phosphate, $\text{Fe}_3\text{P}_2\text{O}_8 \cdot 8\text{H}_2\text{O}$, was reported by Forbes from the Sulphur Spring orebody, New Idria Quicksilver Mine, San Benito County. Woodford made determination.
- No. 141 Axinite, an aluminum and calcium borosilicate, was reported from Sheppard Canyon, on the east slope of the Argus Range, Inyo County.

* Mineral Technologist, Division of Mines.

LIBRARY REPORT

By JAMES M. LITTLE*

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INTRODUCTION

The library of the Division of Mines contains more than 6,000 selected volumes on mines, mining, and allied subjects. It is also the repository for reports and bulletins of technical departments of Federal and State governments and educational institutions both domestic and foreign. Current copies of newspapers published in the mining centers of the State are also available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY AND UNITED STATES BUREAU OF MINES

The library of the Division of Mines has available for public reference the following publications of the United States Geological Survey: Annual Reports, Monographs, Professional Papers, Bulletins, Water-Supply Papers, Mineral Resources, Folios of the Geologic Atlas of the United States (broken file), Maps with Descriptive Text (broken file), Administrative Publications (broken file); and the following publications of the United States Bureau of Mines: Bulletins, Technical Papers, Economic Papers (broken file), Mineral Resources of the United States, Monographs (broken file), Reports of Investigations, Information Circulars.

Reports on California, recently received from the Survey and Bureau of Mines include:

U. S. Geological Survey

Water-Supply Paper

- 918 Summary of records of surface waters at base stations in Colorado River Basin, 1891-1938.

U. S. Bureau of Mines

Reports of Investigations

- 3681 Manganese investigations.

Information Circulars

- 7299 Bureau of Mines exploration of mercury deposits to June 30, 1944.

* Librarian, Division of Mines.

PUBLICATIONS OF STATE SURVEYS

A broken file of mining and geological publications, issued by the organizations listed below, may be consulted in the library of the Division of Mines.

Alabama Geological Survey, University.
 Alaska (Territorial Commissioner of Mines), Juneau.
 Arizona Bureau of Mines, Tucson.
 Arkansas Geological Survey, Little Rock.
 Colorado Bureau of Mines, Denver.
 Connecticut Geological and Natural History Survey, Hartford.
 Florida Department of Conservation, Tallahassee.
 Georgia Division of Geology, Atlanta.
 Idaho Bureau of Mines and Geology, Moscow.
 Illinois Geological Survey, Urbana.
 Indiana Division of Geology, Indianapolis.
 Iowa Geological Survey, Des Moines.
 State Geological Survey of Kansas, Lawrence.
 Kentucky Geological Survey, Frankfort.
 Louisiana Department of Conservation, New Orleans.
 Maine State Geologist, Augusta.
 Maryland Geological Survey, Baltimore.
 Michigan Geological Survey, Lansing.
 Minnesota Geological Survey, Minneapolis.
 Mississippi State Geological Survey, University.
 Missouri Bureau of Geology and Mines, Rolla.
 Montana Bureau of Mines and Geology, Butte.
 Nebraska Geological Survey, Lincoln.
 Nevada State Bureau of Mines, Reno.
 New Jersey Department of Conservation and Development, Trenton.
 New Mexico Bureau of Mines and Mineral Resources, Socorro.
 New York Science Division, Albany.
 North Carolina Geological and Economic Survey, Chapel Hill.
 North Dakota Geological Survey, Grand Forks.
 Ohio Geological Survey, Columbus.
 Oklahoma Geological Survey, Norman.
 Oregon State Department of Geology and Mineral Industries, Portland.
 Pennsylvania Topographic and Geological Survey, Harrisburg.
 South Dakota State Geological Survey, Vermillion.
 Tennessee Division of Geology, Nashville.
 Texas Bureau of Economic Geology, Austin.
 Virginia Geological Survey, University.
 Washington State Department of Conservation and Development, Pullman.
 West Virginia Geological Survey, Morgantown.
 Wisconsin Geological and Natural History Survey, Madison.
 Wyoming Geological Survey, Cheyenne.

PUBLICATIONS OF FOREIGN GOVERNMENTS

Publications of the following foreign governments are received and current issues may be consulted in the library. Earlier issues of foreign-language publications have been loaned to the California Academy of Sciences in Golden Gate Park, because of the limited storage space at the Division's offices in the Ferry Building. They may, however, be consulted at the Academy.

Alberta Research Council, Edmonton.
 Argentina Direccion General de Minas y Geologica, Buenos Aires.
 British Columbia Minister of Mines, Victoria.
 British Museum of Natural History, London.
 Canada Department of Mines, Ottawa.
 Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
 Geological Service of Minas Geraes, Bella Horizonte, Brazil.
 Geological Survey of Scotland.
 Instituto Historica e Geographico, Rio de Janeiro.
 Museo de Historia Natural de Montevideo, Uruguay.
 New South Wales Department of Mines, Sydney, Australia.
 New Zealand Geological Survey Branch, Wellington.
 Nova Scotia Department of Public Works and Mines, Halifax.
 Ontario Department of Mines, Toronto, Canada.
 Quebec Bureau of Mines, Quebec.
 Queensland Department of Mines, Brisbane, Australia.
 South Australia Department of Mines, Adelaide.
 Transvaal Chamber of Mines, Johannesburg, South Africa.
 Western Australia Geological Survey, Perth.

PUBLICATIONS OF FOREIGN AND DOMESTIC SOCIETIES AND EDUCATIONAL INSTITUTIONS

Academia de Ciencias y Artes de Barcelona, Spain.
 Academy of Natural Sciences of Philadelphia.
 American Association of Petroleum Geologists, Tulsa, Oklahoma.
 American Geographical Society of New York.
 American Institute of Mining and Metallurgical Engineers, New York.
 American Journal of Science, New Haven, Conn.
 American Philosophical Society, Philadelphia.
 Australian Museum, Sydney.
 California Academy of Sciences, San Francisco.
 Canadian Institute of Mining and Metallurgy, Montreal.
 Carnegie Institution of Washington.
 Cleveland Museum of Natural History, Cleveland, Ohio.
 Colorado College Publications, Colorado Springs.
 Colorado Scientific Society, Denver.
 Commonwealth Club, San Francisco.
 Economic Geology, Lancaster, Pa.
 Field Museum of Natural History, Chicago.
 Franklin Institute of the State of Pennsylvania, Lancaster.
 Geological Society of America, Columbia University, New York.
 Geographical Society of London.
 Institution of Mining and Metallurgy, London.
 Instituto Geologico de Mexico, Mexico, D. F.
 Journal of Geology, Chicago.
 Mineralogical Society of America, Menasha, Wisconsin.
 Michigan College of Mining and Technology, Houghton.
 Mining and Metallurgical Society of America, New York.
 Missouri School of Mines and Metallurgy, Rolla.
 Museu Nacional, Rio de Janeiro.
 National Research Council, Washington, D. C.
 New York Academy of Sciences, New York.
 New York State Museum, Albany.
 Pennsylvania State College, State College.
 Philippine Journal of Science, Manila.
 Royal Society of South Australia, Adelaide.
 Seismological Society of America, Stanford University.
 Sierra club, San Francisco.
 Society of Economic Paleontologists and Mineralogists, Tulsa, Oklahoma.
 Southern California Academy of Sciences, Los Angeles.
 Stanford University, Palo Alto, California.
 University of California Publications in Engineering, Geography, and Geology, Berkeley.
 University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

CURRENT MAGAZINES

Current issues of the technical magazines listed below are on file in the reading room of the library, and may be consulted.

Asbestos, Philadelphia, Pennsylvania.
 Brick and Clay Record, Chicago.
 California Journal of Development, San Francisco.
 California Mining Journal, Auburn.
 California Oil World, Los Angeles.
 California Safety News, San Francisco.
 Canadian Mining Journal, Gardenvale, Quebec.
 Chemical and Metallurgical Engineering, New York City.
 Chemical Engineering and Mining Review, Melbourne, Australia.
 Civil Engineering, New York City.
 Colorado School of Mines, Golden, Colorado.
 Engineering and Mining Journal, New York City.
 Fuel Oil, Chicago, Illinois.
 Fusion Facts, Whittier, California.
 Gold, Toronto, Canada.
 Grizzly Bear, Los Angeles.
 Hercules Mixer, Wilmington, Delaware.
 Independent Monthly, Tulsa, Oklahoma.
 Lubrication, The Texas Co., New York City.
 Metals and Alloys, Pittsburg, Pennsylvania.
 Mining and Contracting Review, Salt Lake City.
 Mineralogist, Portland, Oregon.
 Mining Congress Journal, Washington, D. C.
 Mining and Industrial News, San Francisco.
 Mining and Geological Journal, Melbourne, Victoria, Australia.
 Mining Journal, London.
 Mining Journal, Phoenix, Arizona.
 Mining and Metallurgy, New York City.
 Mining World, Seattle.

Nickel Steel Topics, New York City.
 Northwest Mining News, Spokane, Washington.
 Oil and Gas Journal, Tulsa, Oklahoma.
 Oil, Paint and Drug Reporter, New York City.
 Oil Weekly, Houston, Texas.
 Pacific Purchaser, San Francisco.
 Petroleum World, Los Angeles.
 Queensland Government Mining Journal, Brisbane, Australia.
 Rock Products, Chicago.
 Rocks and Minerals, Peekskill, New York.
 Scientific American, New York City.
 Southwest Builder and Contractor, Los Angeles.
 Standard Oil Bulletin, San Francisco.
 Stone, New York City.
 Western Mining News, San Francisco.

NEWSPAPERS

Current issues of the following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
 Amador Dispatch, Jackson, California.
 Banner, Sonora, California.
 Barstow Printer, Barstow, California.
 Bridgeport Chronicle-Union, Bridgeport, California.
 Calaveras Californian, Angels Camp, California.
 Calaveras Prospect, San Andreas, California.
 Daily Commercial News, San Francisco, California.
 Del Norte Triplicate, Crescent City, California.
 Denver Mining Record, Denver, Colorado.
 Inyo Independent, Independence, California.
 Inyo Register, Bishop, California.
 Las Vegas Age, Las Vegas, Nevada.
 Livermore Herald, Livermore, California.
 Los Angeles Times, Los Angeles, California.
 Mariposa Gazette, Mariposa, California.
 Mining Press, Reno, Nevada.
 Mohave Miner, Kingman, Arizona.
 Morning Union, Grass Valley, California.
 Mountain Messenger, Downieville, California.
 Needles Nugget, Needles, California.
 Oroville Mercury Register, Oroville, California.
 Placer Herald, Auburn, California.
 Placerville Times, Placerville, California.
 Plumas Independent, Quincy, California.
 Randsburg Times, Randsburg, California.
 Tehachapi News, Tehachapi, California.
 Terra Bella News, Terra Bella, California.
 Tuolumne Independent, Sonora, California.
 Tuolumne Prospector, Tuolumne, California.
 Union Democrat, Sonora, California.
 Weekly Trinity Journal, Weaverville, California.
 Yreka Journal, Yreka, California.

NEW BOOKS

Recent accessions to the library are the following books:

Bowman, W. G., Bulldozers come first, 278 pp., New York, McGraw-Hill Book Co., 1944. (F. W. Bradley Memorial Book Fund.)

Ridgeway, R., Color standards and color nomenclature, 53 plates, Washington, published by the author.

Turrentine, J. W., Potash in North America, 181 pp., New York, Reinhold Publishing Co., 1943.

SERVICES OF THE DIVISION OF MINES

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January 1922, and continued until March 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September 1923. For the same reason, beginning with the January 1924 issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January 1933 chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

TYPES OF REPORTS

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g., feldspar).
3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

Reports of District Mining Engineers

In 1919-1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the frontispiece outline map of the State.

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

Special Articles

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

MAIL AND FILES

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

COMMERCIAL MINERAL NOTES

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial

minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of *Commercial Mineral Notes*, and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco 11; State Building, Los Angeles 12; State Office Building No. 1, Sacramento 14; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

Write for latest revised price list.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Report I of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	-----
**Report II of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	-----
**Report III of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks -----	-----
**Report IV of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks -----	-----
**Report V of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geo- logical map. Henry G. Hanks-----	-----
**Report VI of the State Mineralogist, Part 1, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	-----
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	-----
Price \$0.75, sales tax \$0.02	\$0.77
**Report VII of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. -----	-----
**Report VIII of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	-----
Report IX of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	Price \$1.15, sales tax \$0.03 1.18
**Report X of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	-----
Report XI (First Biennial) of the State Mineralogist, for the two years end- ing September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr. -----	Price \$1.50, sales tax \$0.04 1.54
**Report XII (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford -----	-----
**Report XIII (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford -----	-----
Chapters of the State Mineralogist's Report XIV, Biennial Period, 1913-1914, Fletcher Hamilton :	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Coun- ties, 172 pp., paper-----	-----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper. Price \$0.50, sales tax \$0.01	.51
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Coun- ties, 59 pp., paper-----	Price \$0.35, sales tax \$0.01 .36
Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper-----	Price \$0.75, sales tax \$0.02 .77
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper -----	Price \$0.50, sales tax \$0.01 .51
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper-----	-----
**Report XIV of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915 :	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth -----	-----
Chapters of the State Mineralogist's Report XV, Biennial Period, 1915-1916, Fletcher Hamilton :	

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper -----	
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper -----	Price \$0.50, sales tax \$0.01 \$0.51
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper -----	
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper -----	
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper -----	
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper -----	
**Report XV of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth -----	
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
**Mines and Mineral Resources of Nevada County, 270 pp., paper -----	
Mines and Mineral Resources of Plumas County, 188 pp., paper -----	Price \$0.50, sales tax \$0.01 .51
Mines and Mineral Resources of Sierra County, 144 pp., paper -----	Price \$0.75, sales tax \$0.02 .77
Report XVII of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth -----	Price \$2.50, sales tax \$0.06 2.56
Report XVIII of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, April, May, June, July, August, September, October, November, December, 1922 -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XIX of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XX of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XXI of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925. Mines and Mineral Resources of Sacramento, Monterey and Orange Counties -----	Price \$0.30, sales tax \$0.01 .31
April, 1925. Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties -----	Price \$0.30, sales tax \$0.01 .31
**July, 1925. Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties -----	
**October, 1925. Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties -----	
Chapters of Report XXII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926. Mines and Mineral Resources of Trinity and Santa Cruz Counties -----	
**April, 1926. Mines and Mineral Resources of Shasta, San Benito and Imperial Counties -----	
July, 1926. Mines and Mineral Resources of Marin and Sonoma Counties -----	Price \$0.30, sales tax \$0.01 .31
**October, 1926. Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County -----	

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
Chapters of Report XXIII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927. Mines and Mineral Resources of Contra Costa County ; Santa Catalina Island -----	Price \$0.30, sales tax \$0.01 \$0.31
April, 1927. Mines and Mineral Resources of Amador and Solano Counties Price \$0.30, sales tax \$0.01	.31
**July, 1927. Mines and Mineral Resources of Placer and Los Angeles Counties -----	-----
October, 1927. Mines and Mineral Resources of Mono County -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XXIV of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928. Mines and Mineral Resources of Tuolumne County -----	Price \$0.30, sales tax \$0.01 .31
April, 1928. Mines and Mineral Resources of Mariposa County -----	Price \$0.30, sales tax \$0.01 .31
**July, 1928. Mines and Mineral Resources of Butte and Tehama Counties -----	-----
October, 1928. Mines and Mineral Resources of Plumas and Madera Counties -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XXV of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
**January, 1929. Mines and Mineral Resources of Lassen, Modoc and Kern Counties ; also on Special Placer Machines -----	-----
**April, 1929. Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties -----	-----
July, 1929. Mines and Mineral Resources of Colusa, Fresno and Lake Counties -----	Price \$0.30, sales tax \$0.01 .31
October, 1929. Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XXVI of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930. Mines and Mineral Resources of Santa Clara County ; also Barite in California-----	Price \$0.40, sales tax \$0.01 .41
**April, 1930. Mines and Mineral Resources of Nevada County ; also Mineral Paint Materials in California-----	-----
**July, 1930. Mines and Mineral Resources of Yuba and San Bernardino Counties ; also Commercial Grinding Plants in California-----	-----
October, 1930. Mines and Mineral Resources of Butte, Kings and Tulare Counties ; also Geology of Southwestern Mono County (Preliminary) Price \$0.40, sales tax \$0.01	.41
Chapters of Report XXVII of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931. Preliminary Report of Economic Geology of the Shasta Quadrangle . Beryllium and Beryl . The New Tariff and Nonmetallic Products . Crystalline talc . Decorative effects in Concrete -----	Price \$0.40, sales tax \$0.01 .41
April, 1931. Stratigraphy of the Kreyenhagen Shale . Diatoms and Silicoflagellates of the Kreyenhagen Shale . Foraminifera of the Kreyenhagen Shale . Geology of Santa Cruz Island -----	Price \$0.40, sales tax \$0.01 .41
**July, 1931. (Yuba, San Bernardino Counties .) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County ; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining-----	-----
October, 1931. (Alpine County .) Geology of the San Jacinto Quadrangle south of San Geronio Pass, California . Notes on Mining Activities in Inyo and Mono Counties in July, 1931-----	Price \$0.40, sales tax \$0.01 .41
Chapters of Report XXVIII of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
January, 1932. Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite-----	Price \$0.40, sales tax \$0.01 \$0.41
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining-----	
**Abstract from April quarterly; Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)-----	
**July-October, 1932. (Ventura County). Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville Shasta Succession of California. Geology of a part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist-----	
Chapters of Report XXIX, 1933 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
**January-April, 1933. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic map showing various mines and prospects of part of Del Norte and Siskiyou Counties-----	
July-October, 1933. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming, Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543-----	
	Price \$1.00, sales tax \$0.03 1.03
Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January, 1934. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits-----	Price \$0.60, sales tax \$0.02 .62
April-July, 1934. Elementary Placer Mining in California and Notes on the Milling of Gold Ores-----	Price \$1.00, sales tax \$0.03 1.03
October, 1934. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle, Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas-----	
	Price \$0.60, sales tax \$0.02 .62
Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January, 1935. Review of Gold Mining in East-Central California, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties, Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation--	
	Price \$0.60, sales tax \$0.02 .62

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
April, 1935. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstakes Permits -----	Price \$0.60, sales tax \$0.02 \$0.62
July, 1935. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights -----	Price \$0.60, sales tax \$0.02 .62
October, 1935. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County -----	Price \$0.60, sales tax \$0.02 .62
Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January, 1936. Gold Mines of Placer County, including Drag-line Dredges Geologic Report on Borax Lake, California -----	Price \$0.60, sales tax \$0.02 .62
April, 1936. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum -----	Price \$0.60, sales tax \$0.02 .62
July, 1936. Mines and Mineral Resources of Calaveras County. Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization -----	Price \$0.60, sales tax \$0.02 .62
October, 1936. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco. Biennial Report of the State Mineralogist, Properties and Industrial applications of Opaline Silica -----	Price \$0.60, sales tax \$0.02 .62
Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January, 1937. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold -----	Price \$0.60, sales tax \$0.02 .62
April, 1937. Mineral Resources of Plumas County (with Geologic Map). List of preferred mineral names. New Placer Mining Debris Law. -----	Price \$0.60, sales tax \$0.02 .62
July, 1937. Mineral Resources of Los Angeles County (with map showing principal Mines and Oil Fields). Geology and mineral deposits of the Western San Gabriel Mountains, Los Angeles County -----	Price \$0.60, sales tax \$0.02 .62
October, 1937. Mineral Resources of the Resting Springs Region, Inyo County. Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California. Native Arsenic from Grass Valley, California -----	Price \$0.60, sales tax \$0.02 .62
Chapters of Report XXXIV, 1938 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
**January, 1938. Mineral Development and Mining Activity in Southern California during the year 1937. Doing Something About Earthquakes. Gold and Petroleum in California. Gem Minerals of California, Lapidary Art -----	-----
April, 1938. Gold dredging in Shasta, Siskiyou and Trinity Counties; Geology of the Central Santa Monica Mountains; Marketing Mica -----	Price \$0.60, sales tax \$0.02 .62
July, 1938. El Dorado County, Mineral High-Lights of California; Strategic Minerals of California; Cyanide Treatment of Gossan at Mountain Copper Co.; Submarine Canyons off the California Coast. -----	Price \$0.60, sales tax \$0.02 .62

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
October, 1938. Inyo County, Biennial Report of State Mineralogist, Sulphur Deposits of Inyo County, Geology of the Darwin Silver-Lead Mining District -----	Price \$0.60, sales tax \$0.02 \$0.62
Chapters of Report XXXV, 1939 (quarterly) titled "California Journal of Mines and Geology," containing the following:	
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**Map of El Dorado County, Showing Boundaries, National Forests -----	----
**Map of Madera County, Showing Boundaries, National Forests -----	----
**Map of Placer County, Showing Boundaries, National Forests -----	----
**Map of Sierra County, Showing Boundaries, National Forests -----	----
**Map of Siskiyou County, Showing Boundaries, National Forests -----	----
**Map of Tuolumne County, Showing Boundaries, National Forests -----	----
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**Map of Desert Region of Southern California -----	----
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**Map of Tuolumne County -----	----
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59—Raisin City, Helm and Riverdale, including Wheatville area, Fresno County-----	1.25

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DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY

State Mineralogist

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No. 2

CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY



QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XLI

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State Mineralogist

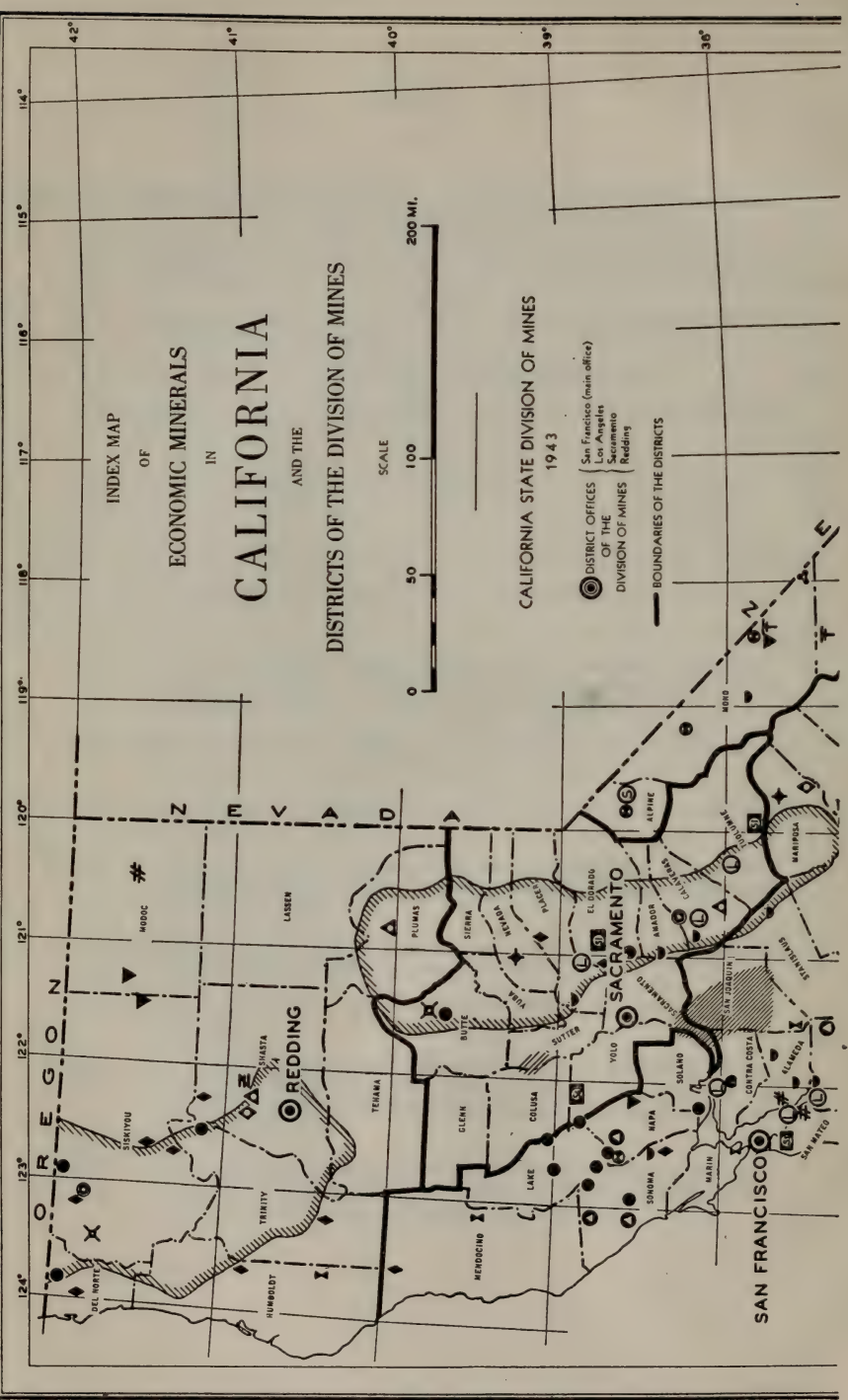
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OF
ECONOMIC MINERALS
IN
CALIFORNIA
AND THE
DISTRICTS OF THE DIVISION OF MINES

SCALE
0 50 100 200 MI.

CALIFORNIA STATE DIVISION OF MINES
1943

- DISTRICT OFFICES OF THE DIVISION OF MINES
○ San Francisco (main office)
○ Los Angeles
○ Sacramento
○ Redding
- BOUNDARIES OF THE DISTRICTS

ECONOMIC MINERALS

FUELS

- GAS DISTRICT
- OIL & GAS DISTRICT

METALS

- CHROMITE
- COPPER
- GOLD DISTRICT
- IRON
- MANGANESE
- QUICKSILVER
- SILVER
- TUNGSTEN
- ZINC-LEAD

NON-METALS

- ANDALUSITE & KYANITE
- BARITE
- BUILDING STONE
- SANDSTONE
- GRANITE
- SLATE
- CLAY
- DIATOMITE
- GEMS
- GYPSEUM
- IODINE
- LIMESTONE, CEMENT, MARBLE
- MAGNESITE
- MICA
- PUMICE
- SALINES
- SOAPSTONE
- SULPHUR
- TALC
- WOLLASTONITE



ADMINISTRATION

ADMINISTRATIVE REPORT

By WALTER W. BRADLEY, STATE MINERALOGIST

Personnel

There have been no changes in personnel to be noted during the past three months.

New Publications

Since last noted, the following publications of the Division of Mines have been received from the State Printer, and are now available at the offices of the Division:

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, April 1944, being Chapter 2 of State Mineralogist's Report XL. This chapter contains: *Administrative Report*; *Current Notes, Geologic Branch*; *Status of Topographic and Geologic Mapping in California*; *Geology of the Jamesburg Quadrangle*, with geologic map; *Mineral Statistics for 1943*; *Accessions to the Mineral Exhibit*; *Laboratory Notes*; *Library Report*; *List of Libraries at which Division of Mines Publications May be Consulted*.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, July 1944, being Chapter 3 of State Mineralogist's Report XL. This chapter contains: *Administrative Report*; *Current Notes, Geologic Branch*; *Progress on Revision of Bulletin 113, "Minerals of California"*; *Mines and Quarries of the Indians of California*; *Fluorescent Minerals in the Exhibit of the State Division of Mines*; *Fluorescent Minerals Used in Lighting and Elsewhere*; *California Mineral Production for 1943*; *Accessions to the Exhibit*; *Library Report*.

GEOLOGIC BRANCH

CURRENT NOTES

By OLAF P. JENKINS*

In this issue

The second of a series of geological reports on quicksilver deposits in California, prepared by the U. S. Geological Survey, appears in this issue of the JOURNAL. It is entitled *Quicksilver Deposits of the Knoxville District, Napa, Yolo, and Lake Counties, California*, by Paul Averitt.

The first of this series of papers on quicksilver was published in the January 1945, JOURNAL: *Quicksilver Deposits of Central San Benito and Northwestern Fresno Counties, California*, by Robert G. Yates and Lowell S. Hilpert. Other similar papers are expected to follow, but these have not yet been submitted finally for publication.

In press

Bulletin 129, *Iron Resources of California*.

Geologic Map of the San Juan Bautista Quadrangle, by John Eliot Allen.

In preparation

In the forthcoming October issue of the JOURNAL will be published a report prepared by the U. S. Geological Survey which has now reached the final editorial stage: *Pine Creek and Adamson Tungsten Mines, Inyo County, California*, by Paul C. Bateman.

The publication of this paper by the Federal Survey constitutes part of the general cooperative program between the Division of Mines and the U. S. Geological Survey.

* Chief Geologist, Division of Mines

QUICKSILVER DEPOSITS OF THE KNOXVILLE DISTRICT NAPA, YOLO, AND LAKE COUNTIES, CALIFORNIA *

By PAUL AVERITT **

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ABSTRACT

The Knoxville district lies at the intersection of Napa, Yolo and Lake Counties, California, 100 miles by road north of San Francisco. It embraces an area of approximately 50 square miles and includes five mining properties: the Knoxville, Manhattan, Harrison, Reed, and Red Elephant mines.

The geology of the district is typical of the northern California Coast Ranges. The Franciscan formation of Jurassic (?) age, the Knoxville formation of Jurassic and Lower Cretaceous age, and serpentine of unknown age are the dominant rock units. These are broken by north-west-trending thrust faults, and overlain in part by Tertiary olivine basalt flows. Basalt dikes, small scattered areas of tuff and hot spring deposits are also present.

Most of the quicksilver deposits occur along or near faults between serpentine and the Knoxville formation, and are confined for the most part to silica-carbonate rock, which was formed locally at the contacts by hydrothermal alteration of serpentine. The ore usually is most abundant in the silica-carbonate rock adjoining gouge zones, although small amounts are present in the gouge and in serpentine. In most cases ore deposition was controlled by local variations in the dip and strike of the fault gouge, which acted as a cap rock. At the Manhattan mine, where

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** Geologist, Geological Survey, U. S. Department of the Interior.

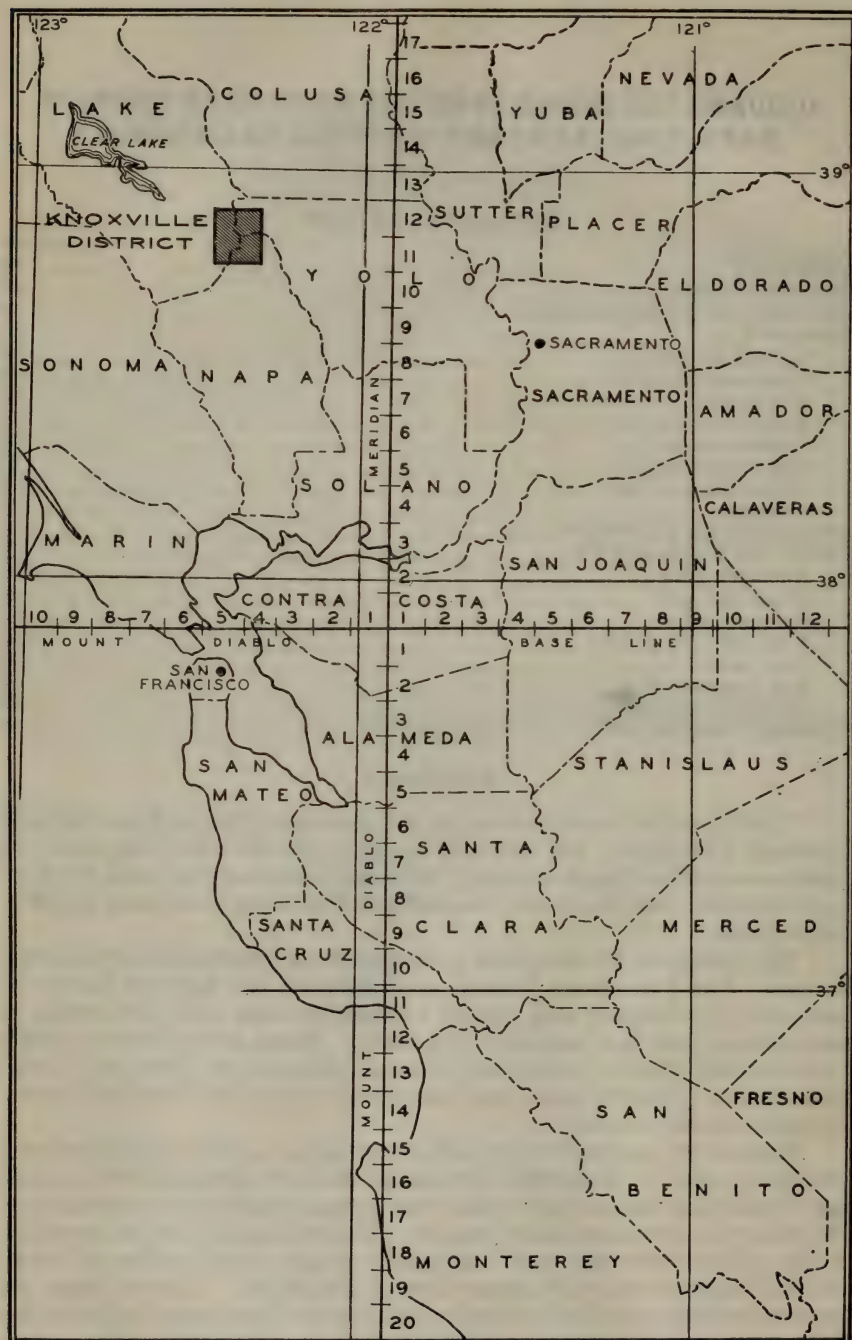
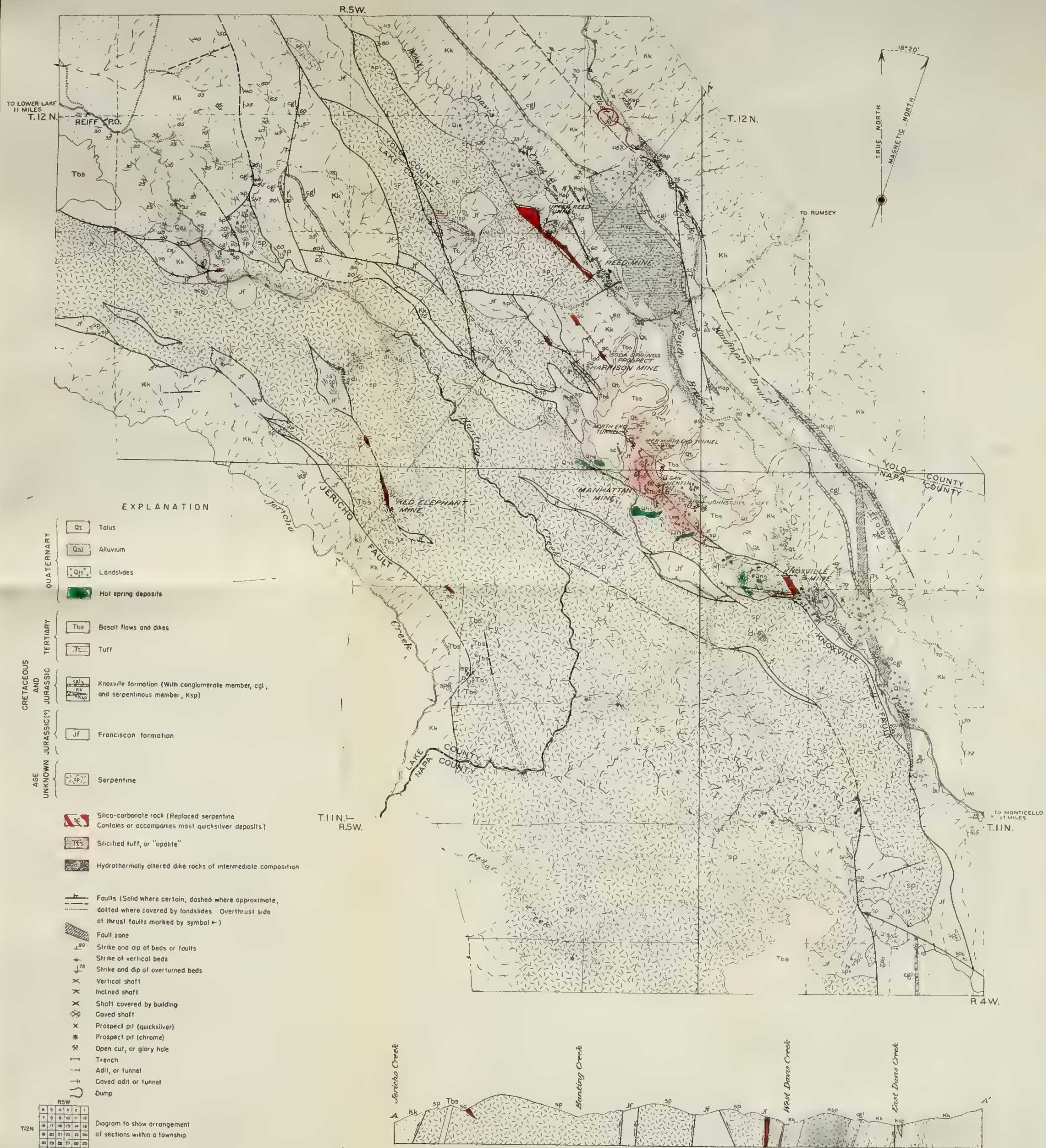


FIG. 1. Index map of northern California showing the location of the Knoxville quicksilver district.





the quicksilver deposits are confined to an area of volcanic rocks, the ore occurs in joint cracks both in silicified tuff, locally called "opalite", and in altered basalt.

The ore occurs as small irregular veins and local disseminations in the silica-carbonate rock and the volcanic rocks. Cinnabar is the most important ore mineral, although metacinnabar and native mercury are also present. Pyrite, marcasite, calcite, dolomite, and quartz are the principal gangue minerals.

The district has yielded a total of approximately 156,000 flasks of quicksilver since production began in 1862. The Knoxville mine, which has yielded 80 percent of the total, reached its peak in 1876. Although underground work on this property has been abandoned, operations are continuing on surface material and old dumps, and a fair rate of production is being maintained. The Reed mine, now the largest producer in the district, is operating on levels below all the old workings, and several good ore shoots have been discovered. The silicified zone in which the ore deposits occur is approximately one mile long, 30 to 110 feet wide, and at least 500 feet deep. It is being prospected systematically by the operators, and although the actual volume of reserves cannot be estimated, in the light of past experience it can be stated with some confidence that the mine is capable of yielding 1,000 to 2,000 flasks per year when the price is at or near \$200 a flask. The other mines in the district, although not important producers, may be expected to yield small quantities of quicksilver from retort and small furnace operations.

INTRODUCTION

The Knoxville quicksilver district, as shown in figure 1, is in T. 11 and 12 N., R. 4 and 5 W., M. D., approximately 100 miles north of San Francisco, California, at the intersection of Napa, Yolo, and Lake Counties. The Knoxville mine, which is a focal point for roads in the district, is 20 miles north of Monticello, and 20 miles southeast of Lower Lake. As defined in this report the district covers an area 10 miles long and 5 miles wide and includes the following mining properties: Knoxville, Manhattan, Harrison, Soda Springs, Reed, and Red Elephant. (See Pl. VI.)

The region is sparsely settled and is not served by a railroad. Brush-covered ridges of moderate relief characterize the topography, which is somewhat less rugged than most of the northern California Coast Ranges. Davis, Hunting, and Eticuera Creeks, the main streams in the district, are permanent in their lower courses, but other streams are intermittent.

The central mineralized part of the district was mapped in 1888 by Becker¹, and the geology of the several mines has been described by Forstner², Bradley³, and Schuette⁴. The present report embodies the results of observations made during August, September, and October, 1941, and later, during the first half of September, 1943. The accom-

¹ Becker, G. F., Geology of the quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, pp. 271-290, 1888. (Atlas)

² Forstner, Wm., Quicksilver resources of California: California Min. Bur. Bull. 27, pp. 76-79, 81-89, 117, 1903.

³ Bradley, W. W., Quicksilver resources of California: California Min. Bur. Bull. 78, pp. 62, 82-83, 86-87, 204-205, 1918.

⁴ Schuette, C. N., Occurrence of quicksilver orebodies: Am. Inst. Min. Met. Eng. Tech. Pub. 335, pp. 25-27, 1930.

panying geologic and planimetric map (Pl. VI) was compiled with plane table control from aerial photographs made by the U. S. Forest Service. The land net that appears on this base was projected from data on General Land Office township plats. A few section corners that were plotted on the photographs by inspection in the field were used for control. The original Land Office surveys of T. 11 N., R. 4 W.; T. 12 N., R. 4 W.; and T. 12 N., R. 5 W., were made between 1875 and 1881, and most of the section corners could not be located. The land lines in these townships, therefore, may not be exactly as shown. However, the land lines in T. 11 N., R. 5 W., which were surveyed in 1928, are accurately located with respect to surface features and geology. Maps of the Knoxville, Reed, Harrison, and Red Elephant mines were furnished by the operators.

The writer is greatly indebted to the mining men in the district for their hospitality and generosity. Special thanks are due Worthen Bradley, Ray Butterfield, Charles Boyd, and J. M. Forrest of the Reed mine; George E. Gamble, T. S. Scribner, and Otto Koopman of the Knoxville mine; C. B. Brady, and D. A. Myers of the Red Elephant mine; Wm. M. Hickox and Charles Wilson of the Manhattan mine; and H. C. Scott of the Harrison mine. E. B. Eckel of the Federal Geological Survey, directed the project and gave much advice and guidance. G. Donald Eberlein assisted in the revision of the mine geology during 1943 and contributed valuable help. Frank C. Calkins examined a collection of igneous rocks from the district, and made many valuable suggestions.

HISTORY AND PRODUCTION

The Knoxville district has yielded more than 156,000 flasks of quicksilver. Production began at the Knoxville mine in 1862 following the discovery of cinnabar in a newly opened road cut. During the succeeding eight years, the Manhattan, Reed, and Harrison mines were discovered and developed, and peak production in the district was reached in 1876. The production record of the individual mines is shown in table 1. The Knoxville mine, which has produced 80 percent of the total for the district, was abandoned in the fall of 1941 after having been active most of the time since its discovery. It now yields quicksilver from dumps, placer, and stripping operations, and was the second largest producer in the district during 1941, 1942, and 1943. The Reed mine, which had been relatively non-productive since 1880, was reopened late in 1939, and by the end of 1941 was the principal producer in the district.

During the last 40 years the Knoxville district, in common with many quicksilver districts in California, has been productive only during such periods as 1927-30 and 1939-43 when prices for quicksilver were high. During 1942 furnaces were in operation at the Reed, Knoxville, Red Elephant and Harrison mines, and a retort was in operation at the Manhattan mine. The total production of 3109 flasks for the year was the highest since 1903. Although production for the district dropped to 2439 flasks in 1943 the rate was still encouragingly high in comparison with former years.

GEOLOGY

General Features

The northern California Coast Range province, of which the Knoxville district is a part, is characterized by many persistent and complex fault zones, most of which trend northwest. Movement along some of these zones has probably continued intermittently since late Jurassic time. In the Knoxville district, Franciscan (Jurassic?) rocks, serpentine of unknown age, and the Knoxville formation of Jurassic and early Lower Cretaceous age are involved in the fault movements. Tertiary lava flows and tuff deposits overlie these faulted rocks in three widely separated areas, and hot spring deposits of late Tertiary, or younger, age occur along the fault zones. In other places hot solutions rising along faults have altered adjacent serpentine to silica-carbonate rock, which locally has been fractured by later minor movements. The quicksilver deposits occur as disseminations and veins in the fractured silica-carbonate rock, or in the volcanic rocks.

Franciscan Formation

The Franciscan formation, of probable Jurassic age, is the oldest formation in the district. This unit contains a large variety of rock types, including shale, mudstone, and sandstone, interbedded with altered lavas, and injected by serpentine. The structural relations within the formation are obscure. Many depositional contacts were observed, but in places the various lithologic units are separated by faults. Contacts between Franciscan and younger rocks are also faulted in most places, although certain irregular and curved contacts with serpentine appear to be intrusive.

In most exposures the Franciscan consists of silty sandstone or feldspathic sandstone. It is fine- to medium-grained, and ranges in color from gray-green on fresh surfaces to brown on weathered surfaces. Bedding generally is obscured by minute fractures, which in places are filled with veinlets of quartz or calcite.

Shale and mudstone, which rarely crop out on the surface, are probably as abundant in the Franciscan as the sandstone. The shale, which frequently is somewhat silty, is typically dark brown to black with occasional small nodules and lenses of chert. In most places the original bedding is largely obscured by deformation.

The lava flows interbedded with the Franciscan sedimentary rocks are fine-grained altered basalt, which hereafter will be called greenstone. This material is heavily stained with iron and manganese along numerous joints and weathering cracks, but on fresh surfaces it is typically green. Locally it contains amygdules of various minerals, and small nodules and lenses of chert. Pillow structures, which are characteristic of these rocks elsewhere in California, were not noted, though they may be present in places.

Serpentine

The serpentine in the Knoxville district is typically light green and highly sheared, with rounded boulders of unsheared material ranging up to 10 or more feet in diameter. These retain the medium- to somewhat coarse-grained texture of the parent ultramafic igneous rock and some specimens show cleavage surfaces on pyroxene or on pseudomorphs after

Table 1—Production record of mines in Knoxville quicksilver district 1862-1943¹
(in flasks)²

Year	Knoxville (Excelsior, Redington, Boston)	Reed (California, Andalusia)	Manhattan (Lake)	Red Elephant	Harrison (New England, Ruby, Grizzly, January)	Total ³	Average price of quicksilver per flask
1860	----	----	----	----	----	-----	53.55
61	----	----	----	----	----	-----	42.05
62	444	----	----	----	----	444	36.35
63	852	----	(a)	----	----	852	42.08
64	1,914	----	(a)	----	----	2,714	45.90
65	3,545	----	(a)	----	----	3,545	45.90
66	2,254	----	(a)	----	----	2,254	53.13
67	7,862	----	(a)	----	----	7,862	45.90
68	8,686	----	(a)	----	----	9,808	45.90
69	5,018	----	(a)	----	----	6,598	45.90
1870	4,546	(b)	(a)	----	----	6,766	57.38
71	2,128	(b)	(a)	----	----	4,098	63.10
72	3,046	(b)	(a)	----	----	4,876	65.93
73	3,294	995	(a)	----	----	5,249	80.33
74	6,678	1,500	(a)	----	----	8,323	105.18
75	7,513	1,500	437	----	----	9,453	84.15
76	9,183	965	976	----	----	12,309	44.00
77	9,399	1,516	439	----	----	11,354	37.30
78	6,686	1,640	----	----	----	8,326	32.90
79	4,516	1,110	----	----	----	5,626	29.85
1880	2,139	422	----	----	----	2,561	31.00
81	2,194	----	----	----	----	2,194	29.83
82	2,171	----	----	----	----	2,171	28.23
83	1,894	----	----	----	----	1,894	28.75
84	881	----	(c)	----	----	881	30.50
85	385	----	----	----	----	385	30.75
86	409	----	----	----	----	409	35.60
87	673	----	----	----	----	673	42.38
88	126	----	----	----	----	126	42.50
89	812	----	----	----	----	812	45.00
1890	505	----	----	----	----	505	52.50
91	442	----	----	----	----	442	45.25
92	728	----	612	----	----	728	40.71
93	1,012	----	578	----	----	1,012	36.75
94	1,200	----	----	----	----	1,200	30.70
95	163	----	455	----	----	618	37.04
96	1,906	----	598	----	----	2,504	34.96
97	1,550	----	453	----	----	2,003	37.28
98	1,012	----	790	----	----	1,802	38.23
99	882	----	542	----	----	1,424	47.70
1900	816	----	----	----	(e)	816	44.94
01	1,545	----	400	----	----	1,945	48.46
02	1,950	----	317	----	----	2,267	43.20
03	1,730	----	284	----	----	2,014	42.25
04	913	----	399	----	----	1,312	37.62
05	223	----	250	----	----	473	35.94
06	----	----	----	----	----	----	36.50
07	100	----	----	----	----	100	38.16
08	100	----	----	----	----	100	42.33
09	17	----	----	----	----	17	47.71
1910	33	----	----	----	----	33	45.23
11	140	----	----	----	----	140	46.01
12	287	----	----	----	----	287	42.04
13	287	(d)	----	----	----	287	40.23
14	77	15	----	----	----	92	49.05
15	58	14	----	----	----	72	81.52

Table 1—Production record of mines in Knoxville quicksilver district 1862-1943¹
(in flasks)²—Continued

Year	Knoxville (Excelsior, Redington, Boston)	Reed (California, Andalusia)	Manhattan (Lake)	Red Elephant	Harrison (New England, Ruby, Grizzly, January)	Total ³	Average price of quicksilver per flask
16	60	---	46	---	---	108	93.50
17	42	14	---	---	13	69	98.29
18	---	---	---	---	30	30	114.03
19	---	---	---	---	220	220	89.04
1920	---	---	---	---	---	---	75.45
21	---	---	---	---	---	---	44.56
22	68	---	---	---	---	68	55.35(f)
23	---	---	---	---	---	---	60.98
24	---	---	---	---	---	---	68.33
25	---	---	---	---	---	---	80.81
26	---	---	---	---	---	---	87.64
27	38	---	9	---	---	47	111.67
28	541	---	---	---	---	541	118.84
29	742	---	---	74	---	816	117.78
1930	970	---	---	154	---	1,124	110.36
31	649	5	---	90	---	744	83.22
32	13	2	1	---	---	16	52.30
33	21	---	3	---	---	24	55.94
34	74	---	---	15	---	89	67.22
35	38	---	---	16	---	54	67.23
36	12	---	2	---	2	16	76.62
37	---	---	131	---	28	159	90.18
38	---	---	72	---	28	100	75.47
39	---	4	33	---	14	51	103.94
1940	75	467	51	---	10	603	176.87
41	458	784	33	---	---	1,275	185.02
42	600	2,422	31	56	(d)	3,109	196.35
43	642	1,771	26	---	(d)	2,439	195.21
Total	121,967	15,146	11,562	405	345	156,458	

¹ Parker, Edward W., U. S. Geological Survey 21st. Ann. Rept. pt. 6, pp. 275-277, 1899, 1900.

Ransome, Alfred L., and Kellogg, John L., California Div. Mines Rept. 35, tables 1 and 2, p. 360, 1939.

Statistical reports to the California State Mineralogist, 1900 to 1940, compiled by David F. Ferris.

Quicksilver mine production in the United States, unpublished compilation by Juanita Crawford, 1943.

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² 76.5 lbs. previous to June 1904; 75 pounds from June 1904 to January 1928; and 76 pounds since January 1928.

³ Includes flasks of unknown origin before 1877.

(a) Manhattan production between 1863 and 1875 totaled 3,594 flasks.

(b) Amount of production unknown.

(c) Intermittent unrecorded production between 1884 and 1892.

(d) Small unrecorded production.

(e) Pre-1900 production small and unrecorded.

(f) Tariff Act of 1922 placed import duties of \$18.75 per flask.

pyroxene. Small veins and networks of chrysotile asbestos are quite noticeable, both in the boulders and in the highly sheared serpentine.

The large mass of serpentine that crops out over most of the southern and western part of the district is dissected by Hunting Creek and its tributaries, and along the lower course of Hunting Creek there are almost continuous fresh exposures. Here the center of the mass contrasts sharply with the eastern and western borders. The center is composed of massive, jointed, relatively unsheared serpentine that retains the original igneous rock texture, whereas the zones outward from the center are partly sheared, and the border zones are highly sheared for a distance of as much as half a mile away from the contact. The actual contacts, moreover, are marked in many places by gouge, which locally contains small bodies of schist in which the dominant minerals are glaucophane, crossite, and other amphiboles. These contact zones, which dip 70° to 90° W. on both edges of the mass, also contain numerous large linear blocks of Franciscan rock that probably were dragged into position during emplacement of the serpentine. Because of its larger size, and because it retains a central core of relatively unsheared serpentine, the Hunting Creek mass is unique in the district. In all other particulars, however, it resembles the smaller masses of serpentine.

Included in the serpentine, particularly near the borders of the larger masses, are many blocks of diorite and gabbro, which originally may have been dikes in the parent igneous mass. Greenstones and other rocks of the Franciscan formation are also common as inclusions. The blocks attain mappable size in many instances, but in general they lack continuity, and it is assumed that they were broken and transported during the emplacement of the serpentine. Most of the included blocks of igneous origin are fine-grained, and green on fresh surfaces. In general, they were altered during the process of serpentinization, and the distinction between them and included greenstone masses of the Franciscan formation is hard to make on field evidence alone. No attempt was made to separate the dike rocks from serpentine on the geologic map (Pl. VI), but most of the larger greenstone masses of the Franciscan near serpentine contacts are shown. Several small areas of intrusive rock that are outlined on Plate VI are notable because they have been more highly altered than typical inclusions. In each of these instances the original feldspathic rock now contains albite, zoisite, epidote, and chlorite, and appears to represent the locus of later (or prolonged) hydrothermal activity.

Small pods of chromite occur in many places in the serpentine bodies. Most of these have been prospected, and a few have yielded small amounts of ore. The locations of the prospects are indicated on the geologic map (Pl. VI). One occurrence that has not been prospected, but which shows approximately 100 pounds of chromite on the surface, is also indicated in the SW $\frac{1}{4}$ sec. 33, T. 12 N., R. 5 W.

Knoxville Formation

As used in this report, the Knoxville formation includes all beds between the Franciscan formation below and the Horsetown formation above, following the original usage of Diller and Stanton.⁵ The lower

⁵ Diller, J. S., and Stanton, T. W., *The Shasta-Chico series*: Geol. Soc. America Bull., vol. 5, pp. 435-464, 1894.

part of the formation below a zone of coarse conglomerate beds has been determined to be of Jurassic age by Anderson⁶, Knowlton⁷ and Taliaferro⁸ and others, in contrast to the upper part which is unquestionably of Lower Cretaceous age. The term Knoxville, therefore, is used in a restricted sense by many writers to refer to these lower beds, whereas the upper beds, including the conglomerate zone are called the Paskenta formation. A prominent conglomerate zone containing granite boulders as much as 1 foot in diameter that is present in the Knoxville district, is interpreted by the writer as being the base of the Paskenta of most California writers. It should be noted, however, that the conglomerate zone represents a short period of rapid diastrophic changes, during which areas of sedimentation changed with movements of the land mass. It is probable, therefore, that the conglomerate zones were deposited at slightly different times as the movements of the land mass progressed from one area to another, and that local conglomerate zones, representing the same diastrophism in different areas, may occur lower or higher in the section.

The relationship between the Knoxville formation as originally defined, the restricted Knoxville formation, and the Paskenta formation; and also the stratigraphic position of the provisional boundary between the Knoxville restricted and the Paskenta as recognized by the writer for this area are shown in figure 2.

The Knoxville below the coarse conglomerate of the Paskenta will be called the Knoxville restricted. It is in fault contact with the Franciscan in a small area near the Harrison mine in the corner of secs. 26, 35, and 36, T. 12 N., R. 5 W., and in contact with serpentine elsewhere in the district. The exposed beds total 5,000 to 6,000 feet in thickness. In general, these rocks are more shaly than the Franciscan, and bedding is better developed. The lower half of the unit is mostly non-fossiliferous gray shale. This is overlain by a zone of pebble conglomerate 100 feet thick, the individual pebbles of which are composed of chert, quartzite, and fine-grained silicic igneous rocks. No pebbles of mafic igneous rock were observed. Near the minor fault at the Reed mine many pebbles in the conglomerate are slightly fractured and mineralized. The beds between the pebble conglomerate and the coarse conglomerate at the base of the Paskenta contain more sandstone than the beds below, and in addition are marked by an abundance of *Aucella* (*Buchie*). The Paskenta above the coarse conglomerate is somewhat more sandy and less fossiliferous than the beds below. It grades without noticeable break into the overlying Horsetown formation, which lies east of the mapped area.

A few hundred feet below the base of the Paskenta, and also 1,000 to 1,500 feet above it are two sedimentary serpentinous zones of the type described by Arnold and Anderson⁹ in the Coalinga district, Schloeker

⁶ Anderson, F. M., The Knoxville-Shasta succession in California: Geol. Soc. America Bull., vol. 44, pp. 1237-1270, 1933.

Anderson, F. M., Lower Cretaceous deposits in California and Oregon: Geol. Soc. America Spec. Paper No. 16, 1938.

⁷ Knowlton, F. H., The Jurassic age of the Jurassic flora of Oregon: America Jour. Sci., 4th ser., vol. 30, pp. 33-64, 1910.

⁸ Taliaferro, N. L., Geologic history and correlation of the Jurassic of southwestern Oregon and California: Geol. Soc. America Bull., vol. 53, pp. 71-112, 1942.

⁹ Arnold, Ralph, and Anderson, Robert, Geology and oil resources of the Coalinga district, California: U. S. Geol. Survey Bull. 398, pp. 89-90, 1910.

HORSETOWN FORMATION				
KNOXVILLE FORMATION	PASKENTA OF CALIFORNIA WRITERS		5000+	GRADATIONAL CONTACT WITH HORSETOWN NOT ESTABLISHED. SANDSTONE AND SHALE CONTAINING EARLY LOWER CRETACEOUS FOSSILS INCLUDING AUCELLA SP. IN SMALL NUMBERS. SERPENTINOUS ZONE COARSE CONGLOMERATE CONTAINING GRANITE BOULDERS.
	KNOXVILLE RESTRICTED OF CALIFORNIA WRITERS		5000 TO 6000	SERPENTINOUS ZONE SHALE AND SANDSTONE. AUCELLA PIOCHI, A. CRASSA, AND A. CRASSICOLLIS ABUNDANT. PEBBLE CONGLOMERATE GRAY SHALE. FOSSILS RARE.
	FRANCISCAN FORMATION			FAULT CONTACT

Fig. 2. Generalized section of the Knoxville formation, Knoxville quicksilver district, California.

and Owens¹⁰ in the Wilbur Springs district; and recognized by Myers¹¹ to extend over large areas in that district. These serpentinous sediments have also been described by Taliaferro¹². In the Knoxville district the lower of the two serpentinous zones crops out on the hill east of the Reed mine and is a lens-shaped mass 2 miles long and 2,000 feet thick. It is composed of beds of finely shredded, reworked serpentine alternating with beds composed of both clay and shredded serpentine. The upper zone, which is approximately 150 feet thick and extends the full length of the mapped area, is a more typical sedimentary member. It consists of a series of thin, discontinuous beds composed of finely shredded serpentine and clay alternating with shale. The serpentinous material, which is not everywhere at the same stratigraphic position, usually makes up one-third of the zone. A characteristic feature of the serpentinous zones is the presence of occasional boulders of serpentine together with smaller boulders of shale in the detrital serpentine and clay matrix. In the lower, thicker member these boulders range up to 10 feet in diameter. The serpentinous material is highly plastic, and the upper serpentinous member has become a zone of movement along much of its extent. Where this has occurred, or where there have been landslides, the disturbed material resembles fault gouge.

The rock sequence beginning with the lower conglomerate zone in the Knoxville restricted, and extending up through the lower serpentinous zone and the coarse conglomerate at the base of the Paskenta, undoubtedly represents deposition during a period of diastrophic movement. The coarse conglomerate that is taken as the base of the Paskenta is the only local mappable geologic boundary within this sequence. As noted above, however, distinctive changes in lithology, and hence mappable units, may occur at different places in the sequence in other areas.

Volcanic Rocks

The volcanic rocks in the Knoxville district include flows, dikes, and tuff of Tertiary age. Olivine basalt flows which form distinct, mesa-like hills occur in three areas (see Pl. VI). Dikes of the same composition crop out on the west-central edge of the district. The association of the quicksilver deposits with the central flows and the west-central dikes is quite marked, and mineralization is believed to have followed shortly after igneous activity in each locality.

The central flows, which were studied more carefully than the others, are interbedded with tuff in the vicinity of the Manhattan mine. Of particular interest is the fact that these volcanic rocks dip outward both to the east and west from a line conforming roughly with the crest of the ridge separating Napa and Yolo Counties. On the east side of the ridge, particularly, the flows extend well down the slopes, and the suggestion everywhere is that the central volcanic rocks were deposited on a surface not greatly different from the present surface.

Bedded rhyolite tuff was noted in several places in the district. Most conspicuous are the "opalite" deposits at the Manhattan mine. (See Pls. VI and VII.) These are fine-grained, silicified tuff beds, which

¹⁰ Schlocker, Julius, and Owens, J. S., *Geology of parts of Colusa and Lake Counties, California*: thesis, University of California Library. 1941.

¹¹ Myers, W. B., Personal communication, October 1941.

¹² Taliaferro, N. L., *Franciscan-Knoxville problem*: Am. Assoc. Petroleum Geologists Bull. vol. 27, pp. 206-207, 1943.

resemble bedded white chert and stand above the surrounding softer, unsilicified tuff and altered basalt. Much of the cinnabar at the Manhattan mine occurs as veins in this material. The most interesting occurrence is the San Quentin glory hole near the entrance to the property. This is made up of several interconnected pits that have been cut into a small hill of silicified tuff. The beautiful banding in the chert-like layers is well exposed here in vertical walls 50 or more feet high. Here also may be seen vertical cinnabar veins cutting across the bedding. Nearby, at the Johnstown shaft, unsilicified tuff beds are exposed in the creek bottom.

East of the Knoxville mine there is a small area of unsilicified tuff lying parallel to and along the ridge between Eticuera Creek and Foley Canyon. Partly silicified tuff beds occur also on the ridge crest in sec. 22, T. 12 N., R. 5 W., and scattered fragments of this material were noted southward along the divide between Napa and Yolo Counties.

Most of the areas of volcanic rocks in the Knoxville district are closely associated with faults between serpentine and the Knoxville formation. The central and northwestern flows, in particular, are underlain by such faults, and it is likely that the basalt came to the surface along the fault planes. In some places there is the suggestion that tuff deposits have been broken by minor movements along these faults. At the Manhattan mine, for example, a small isolated outcrop of glaucophane schist and serpentine lies in an area of silicified tuff directly over a fault in the older rocks and may have been faulted into position. Similarly, at the upper North-End tunnel in sec. 36, T. 12 N., R. 5 W., on the Manhattan property a dike-like mass of basalt apparently has been intruded along a fault between serpentine and tuff. A small outcrop of tuff on the low part of the ridge east of the Knoxville mine is near, if not on, a fault zone in the Knoxville formation.

Hot Spring Deposits

Several different kinds of hot spring deposits are shown on the geologic map (Pl. VI). Most common are layered calcareous and siliceous sinter deposits. Next in abundance is an impure variety of silica that resembles opal. This material occurs both as veins in typical sinter and as separate deposits. A third kind of deposit, which might have been described under volcanic rocks, consists of very loosely packed pumiceous tuff cemented and veined by opal. The best exposure of this material is near the center of sec. 1, T. 11 N., R. 5 W.

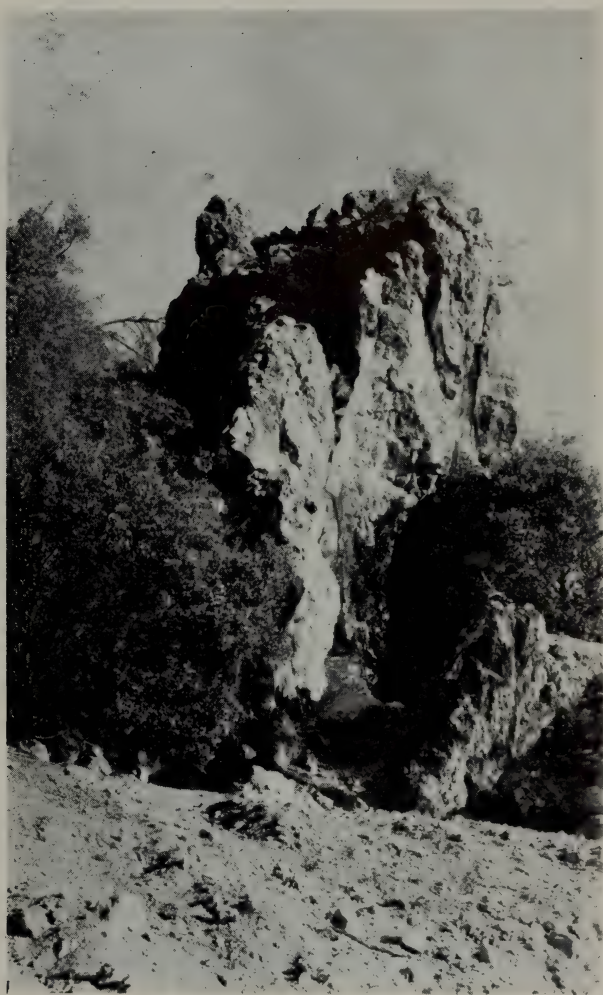
Of particular interest is the fact that all these deposits are concentrated along the fault contact between serpentine and Knoxville strata, and are parallel to the mineralized zones in the Knoxville and Manhattan mines. The hot springs deposits, however, do not yield quicksilver in any appreciable quantity.

Silica-Carbonate Rock

Silica-carbonate rock occurs on all the mining properties in the Knoxville district. Typically it is a hard, black, vitreous, highly siliceous rock that has been formed by the hydrothermal replacement of serpentine by silica and carbonate. It occurs along fault contacts between serpentine and other rocks. Locally, "ledges" of this material



SILICIFIED TUFF, MANHATTAN MINE, KNOXVILLE QUICKSILVER DISTRICT, CALIFORNIA



OUTCROP OF SILICA-CARBONATE ROCK, SODA
SPRINGS PROSPECT, KNOXVILLE
DISTRICT, CALIFORNIA

occur within serpentine, as at the Red Elephant mine, or in sedimentary rocks, as at the Soda Springs prospect. Carbonates, which characteristically are important constituents of silica-carbonate rock in most other California quicksilver districts, are present in small quantities. Locally, the silica-carbonate rock is heavily mineralized with iron sulphides, and weathered outcrops of this material form resistant reddish-brown masses (see Pl. VIII) and contain stringers of unweathered, black silica-carbonate rock.

Except for the Manhattan mine, most of the quicksilver deposits in the Knoxville district occur as veins or disseminations in silica-carbonate rock, and every outcrop of this material has been extensively prospected. The silica-carbonate rock, however, does not contain quicksilver at every locality, and the presence of a "ledge" is merely a guide in prospecting, rather than an index to ore occurrences.

Structure

In interpreting the structure of the Knoxville district, the mode of emplacement of the large serpentine masses that underlie most of the mapped area may advantageously be considered first. Some information bearing on this problem is found in the relation between the serpentine and the many included Franciscan blocks along the edges of the large Hunting Creek mass. Most of these inclusions, which were described in part in the section on serpentine, are distinctly linear, the serpentine adjoining them is highly sheared, and there is no direct evidence of contact alteration. The glaucophane schists, which in some parts of California have been considered to be contact metamorphic products of serpentine, are confined largely to fault zones in the Knoxville district.

As stated in the chapter on serpentine, the absence of shearing in the central part of the serpentine mass on Hunting Creek is especially noticeable, as is also the absence of Franciscan inclusions. Furthermore, the Knoxville rocks adjoining the serpentine have not been altered, though locally a gouge has been developed at the contact.

These facts suggest that the mass on Hunting Creek was faulted into position as serpentine, and that the wide border zones, which were under the greatest stress and are highly sheared, behaved essentially as if they were composed of plastic material. This type of emplacement with a relatively undisturbed central core is, therefore, somewhat different from that in the New Idria district where the serpentine was injected as a "pulp."¹³

It is noteworthy that the serpentine contacts are the major structural lines in the district, and that gouge zones are confined to these contacts. Locally, of course, there are places along serpentine contacts where there is no evidence of movement, but it is easier there to assume that the movement was dissipated in the serpentine than it is to assume that no major faults traverse the district.

On the accompanying geologic map, therefore, most of the contacts between serpentine and other rocks are shown as faults. Of these, the two most important, here called the Knoxville fault and the Jericho Creek fault, form the boundaries of the mass on Hunting Creek. In general, they strike northwest and dip steeply southwest parallel to the

¹³ Eckel, E. B., and Myer, W. B., Quicksilver deposits of the New Idria district, San Benito and Fresno Counties, California (in preparation, U. S. Geological Survey).

trend of the regional geology. Like the other faults in the district they are interpreted as thrust faults along which there was a small amount of horizontal movement. The Knoxville and Jericho Creek faults are arcuate, trending nearly north in the southern part of the district, and nearly west in the northwestern part. The serpentine mass between these faults apparently overrides the northwest-trending faults that terminate against the Knoxville fault in sec. 17, T. 11 N., R. 4 W.; sec. 1, T. 11 N., R. 5 W.; and secs. 27 and 36, T. 12 N., R. 5 W.; but whether this is the case or not could not be determined by field evidence.

Viewed as a whole the district exhibits two very distinct structural trends, both of which blend into the arcuate pattern of the Knoxville and Jericho Creek faults. The major trend is indicated by the southern end of the Knoxville fault, the fault at the Harrison mine, the fault at the Reed mine, and the strike of the Knoxville strata in the eastern part of the district, all of which trend a few degrees west of north. The minor trend is seen in the parallelism of the several cross faults that break the Knoxville fault, and the northwestern end of the Knoxville fault, all of which strike a few degrees north of west.

Two of the minor cross faults that break the Knoxville fault occur at the Knoxville mine where there is a change in the trend of the Knoxville fault. Here the mineralized zone is confined to a small block between these faults. Apparently this block has been rotated approximately 45° on a north-northwest-trending horizontal axis, the upper half moving differentially west and the lower half moving differentially east. In any event, the serpentine-Knoxville contact in the mine workings dips to the east at 45° , whereas, a few hundred feet south of the south cross fault the contact has been proven by drilling to be nearly vertical, and other evidence shows that it dips steeply to the west farther south along the trace of the Knoxville fault.

QUICKSILVER DEPOSITS

Most of the quicksilver deposits in the Knoxville district are confined to silica-carbonate rock along the northwest-trending faults. In the Manhattan mine, the only exception to this generalization, the ore occurs in volcanic rocks. Cinnabar (HgS) is by far the most important ore mineral. In the early days of mining, however, the black mercury sulphide, metacinnabar, was found in considerable quantities in the upper levels of both the Knoxville and the Reed mines. Native mercury has been observed as fine globules lining cavities in several mines. It is most abundant in the Red Elephant mine, but nowhere does it constitute more than a small fraction of the ore. Gangue material other than the silica-carbonate rock is mostly pyrite and marcasite (FeS_2), calcite (CaCO_3), dolomite $\text{CaMg}(\text{CO}_3)_2$, and certain liquid and solid hydrocarbons, including curtisite, which has been noted in considerable quantities in the Knoxville mine. The cinnabar is later in occurrence than any of the other minerals with the exception of part of the carbonates and all of the hydrocarbons, which were deposited in the final stages of mineralization.

Several rare minerals occur in the district. Redingtonite, a hydrous chromium sulphate, was discovered in the Knoxville mine, and this is its only known occurrence. Millerite (NiS) has been reported in microscopic quantities, and tests of the pyrite show traces of gold. In

sheltered places weathered outcrops of the ore-bearing silica-carbonate rock which normally are stained red or brown by iron oxide, locally exhibit crusts of yellow iron sulphates.

In all of the mines except the Manhattan, the ore occurs as discontinuous veins and irregular masses of cinnabar contained for the most part in minute fracture systems in, or near, silica-carbonate rock. The silica-carbonate rock, which has been described in earlier pages of this report, is serpentine that has been replaced by silica and carbonates in hot solutions. In the Knoxville, Harrison, and Reed mines the solutions moved upward along fault contacts between serpentine and Knoxville sediments, replacing the serpentine in a narrow belt. Heavy clay gouge zones formed by the movement along the faults made effective barriers that prevented the dissipation of the solutions through the adjoining sediments. Shortly after its formation the silica-carbonate rock was fractured slightly by minor movements along the faults, and mercury-bearing solutions, rising during the last phase of hydrothermal activity, permeated these fractures and deposited cinnabar. In general, the ore is more abundant in the silica-carbonate rock at the gouge contacts where the solutions were concentrated, but some ore occurs within the gouge zones as well.

Mineral deposition was controlled by local changes in the dip and strike of the gouge zones. In the Reed mine, particularly, where the contact between silica-carbonate rock and gouge is in most places nearly vertical, the ore shoots occur under hanging walls of gouge produced by local reversals in dip. This is illustrated in the cross-sections on Plate XII. In general, the ore shoots are small in all dimensions, but several have been mined continuously for vertical distances of more than 150 feet.

In the volcanic rocks of the Manhattan mine the ore occurs primarily along joint cracks in both basalt and tuff, and occasionally along bedding planes in tuff.

The grade of ore in the district has dropped steadily during the many years of mining operations, and the average yield from the operating mines during 1943 was between 5 and 10 pounds of mercury per ton.

MINES AND PROSPECTS

Quicksilver has been obtained from six mining properties in the Knoxville district, which are discussed below in the following order: Knoxville, Manhattan, Harrison, Soda Springs, Reed, and Red Elephant. In addition, certain pertinent data are given for each in tables 1 and 2. Several isolated quicksilver occurrences that have been prospected without success are also discussed. Most of these properties have had a long mining history during which the general interpretations of the geology have changed with each new phase of development, and appraisals of ore reserves have varied with the price of quicksilver. During this time no systematic geologic observations were planned to keep pace with developments, and although the region was visited at intervals by geologists and mining engineers, no one person has ever had anything approaching a comprehensive view of the underground geology because workings usually cave within a short time after they are abandoned. As early as 1888 Becker¹⁴ wrote concerning the Knoxville mine, "At the

¹⁴ Becker, George F., *Geology of the quicksilver deposits of the Pacific slope*: U. S. Geol. Survey Mon. 13, p. 231, 1888.

time of my visit (1883) . . . the greater part of the workings were entirely inaccessible." The summary descriptions that have been published by the California Division of Mines¹⁵ are therefore of great value in that they record the results of observations by several individuals at various times in places where observations can no longer be made.

Knoxville Mine

The Knoxville mine, owned and operated by George E. Gamble, is in secs. 6 and 7, T. 11 N., R. 4 W., M. D., in the northern part of Napa County. Under various owners the property has also been known as the Excelsior, Redington, and Boston mine. By the end of 1943 it had produced more than 121,000 flasks of quicksilver, approximately 80 percent of the total for the district. This record is exceeded by only three mines in the State of California. Production at the Knoxville mine began in 1862, following the discovery of cinnabar in a newly opened road cut, and increased to a peak in 1876 and '77. During succeeding years the quantity and grade of ore gradually declined, and the mine was abandoned, and reopened several times. Some production, however, has been recorded for most of the years of its long life (see table 1). The mine was abandoned late in 1941 after extensive exploration for ore on the old 90, 150, and 210 levels had proved unprofitable, but quicksilver was still being produced at the end of 1943 from alluvial

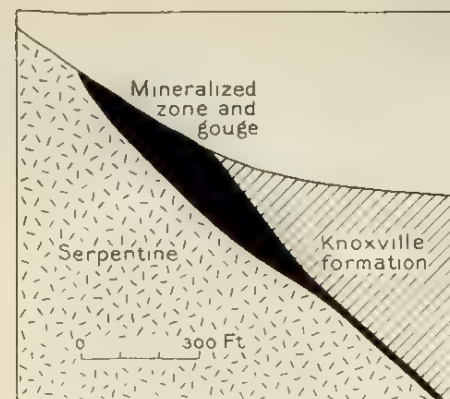
Table 2—Record of mines in the Knoxville district Napa, Yolo, and Lake Counties, California

Mine	Location			Owner	Operator	Length of workings (feet, estimated)	Reduction equipment
	T. N.	R. W.	Sec.				
Knoxville	11	4	6, 7	G. E. Gamble	G. E. Gamble	15,000	40-ton rotary
Manhattan	11	4	6	R. B. Knox	Charles Wilson and W. M. Hickox		1-tube retort
	11	5	1				
	12	5	36				
Harrison	12	5	26 35	Verne and Vince Harrison	H. C. Scott		30-ton rotary
Soda Springs	12	5	36	Verne and Vince Harrison	H. C. Scott		
Reed	12	5	23	Bradley Mining Company	Bradley Mining Company		13-ton rotary (abandoned) 40-ton rotary
			24				
			25				
			26				
Red Elephant	11	5	3	Z. Gradine	Red Elephant Mines, Inc., H. D. Tudor, Pres.		

¹⁵ Forstner, Wm., The quicksilver resources of California: California Min. Bur. Bull. 27, pp. 76-79, 81-89, 117, 1903.

Bradley, W. W., Quicksilver resources of California: California Min. Bur. Bull. 78, pp. 62, 82-83, 86-87, 204-205, 1918.

Ransome, A. L., and Kellogg, J. L., Quicksilver resources of California: California Div. Mines Rept. 35, no. 4, pp. 395, 409-411, 475, 1939.



Diagrammatic cross-section showing variation in width of mineralized zone and gouge between upper and lower mine levels

EXPLANATION

- ☒ Foot of raise or winze
- ☐ Head of raise or winze
- ▤ Inclined raise or winze
- ⬇ Head of shaft going only to lower levels
- ⬆ Vertical shaft going above and below level
- ▤ Inclined shafts
- Open workings, heavy lines
- Caved workings, light lines
- - - Hanging wall shale gouge zone on individual levels
- ⋈ Incline; chevrons point down



KNOXVILLE MINE WORKINGS NAPA COUNTY, CALIFORNIA

100 50 0 100 200 Ft
1941

placer material, from weathered and slumped surface debris near the outcrop of the mineralized zone, and in limited amounts from old dumps.

The mine lies on the Knoxville thrust fault, which brings serpentine in contact with Knoxville strata. Two east-trending cross faults, which probably were produced by the change in trend of the Knoxville fault at this point, break the continuity of the Knoxville fault north and south of the mine, and limit the extent of mineralization. The block between these two cross faults apparently was rotated approximately 45° on a north-northwest-trending horizontal axis during compression, the upper half moving differentially to the west. In any event, the serpentine-Knoxville contact dips east at an angle of 45° in the block, whereas elsewhere it is nearly vertical.

The ore in the Knoxville mine occurs in black silica-carbonate rock that is confined to the Knoxville fault in the zone between the two cross faults, and to a short, narrow belt along the south cross fault. In the upper part of the mine serpentine, gouge, and silica-carbonate rock are irregularly distributed, and in some places several parallel silica-carbonate "ledges" occur, each underlying a gouge zone. Lower in the mine, below the 210 level, the mineralized zone is well defined as a single fault and is much narrower than it is above. The contrast between the widths of the mineralized zone in the upper and lower parts of the mine is well illustrated by the map of the mine workings (Pl. IX).

The increase in width upward of the gouge and mineralized zone, from the lower to the upper mine levels, suggests that ore was probably deposited near a surface not far above the present ground surface and possibly under an extension of the nearby lava flows as described by Schuette.¹⁶

The mineralized zone in the mine has been prospected down to the 600 level (Pl. IX). The ore, however, is said to have contained more pyrite and less cinnabar on the lower levels, and extensive development was carried on only to the 330 level.

Southward, the workings on all levels terminate abruptly along a north-northeast-trending line, and it is obvious that prospecting in this direction was unsuccessful. It is interesting that the south cross fault, which forms the boundary of the mineralized block on the surface, does not coincide with this line. In the absence of any specific surface or underground information bearing on this point it may be assumed that a subordinate northeast-trending fault formed a barrier to ore deposition to the south at the position indicated by the zone of crosscuts near the ends of the workings.

As the extent of mineralization has also been limited by a fault to the north it follows that any further attempts to obtain ore must be made in the lower levels of the mine. The workings below the 210 level, and particularly those below the 330 level, were abandoned many years ago when the price of quicksilver was much lower, and some low-grade ore may still remain in place and in stope fill. It is unlikely, however, that there will be a recurrence at depth of a broad, rich mineralized zone such as existed in the upper levels.

¹⁶ Schuette, C. N., Occurrence of quicksilver orebodies: *Am. Inst. Min. Met. Eng. Tech. Pub.* 335, pp. 25-26, 1930.

Manhattan Mine

The Manhattan mining property, which lies on the Lower Lake road one mile northwest of the Knoxville mine, consists of a mineralized area one mile long and several hundred yards wide in Tertiary volcanic rocks. The total recorded production from the property to the end of 1943 is about 8,000 flasks. The amount produced, however, must have been considerably larger because in the early days of mining various individuals in different parts of the mineralized area sold their stocks in different markets. It is believed by some that the total production from the property is of the order of 16,000 flasks¹⁷.

The rocks at the Manhattan mine consist of interbedded Tertiary olivine basalt and tuff overlain in part by hot spring deposits. The flows and tuffs dip 20°-50° SW. away from the crest of the ridge, which lies a short distance northeast of the mineralized area. As stated in the section on volcanic rocks, it is probable that these rocks were deposited on a sloping surface not greatly different from the present surface, although they may have been tilted somewhat by later movements. The fact that the volcanic section comprises at least two flows and two intercalated beds of tuff makes it impossible to show the precise distribution of the two rock types on a small-scale map. In general, however, the ridge top is underlain by basalt, and the lower slopes by tuff as shown on Plate VI.

As seen on the geologic map (Pl. VI) the volcanic rocks at the Manhattan mine are underlain by a fault, which brings the Franciscan formation in contact with Knoxville strata. This fault is exposed only at the north and south ends of the property, but its position under the volcanics is indicated by a small outcrop of serpentine and glaucophane schist in the extreme north-central part of sec. 1, T. 11 N., R. 5 W., and by the distribution of the Franciscan and Knoxville formations outside the area covered by volcanics.

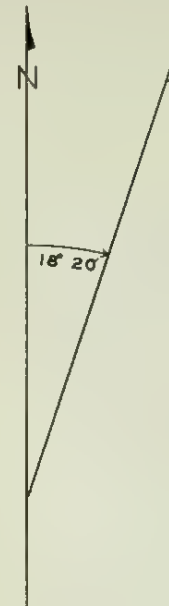
Most of the volcanic rocks in the vicinity of the Manhattan mine have been altered by hydrothermal solutions. The basalt is bleached and partly kaolinized, and the tuff is either similarly altered or silicified. An exception to this generalization is a fine-grained variety of relatively unaltered tuff closely resembling shale, the "mudrock" of the miners, which is exposed near the Johnstown shaft, and at the entrance to the North-End tunnel.

The silicified tuff, which is locally called "opalite," resembles bedded white chart, and usually stands above the surrounding softer rocks. (See Pl. VII). The best exposure of this material is in the San Quentin glory hole near the entrance to the property.

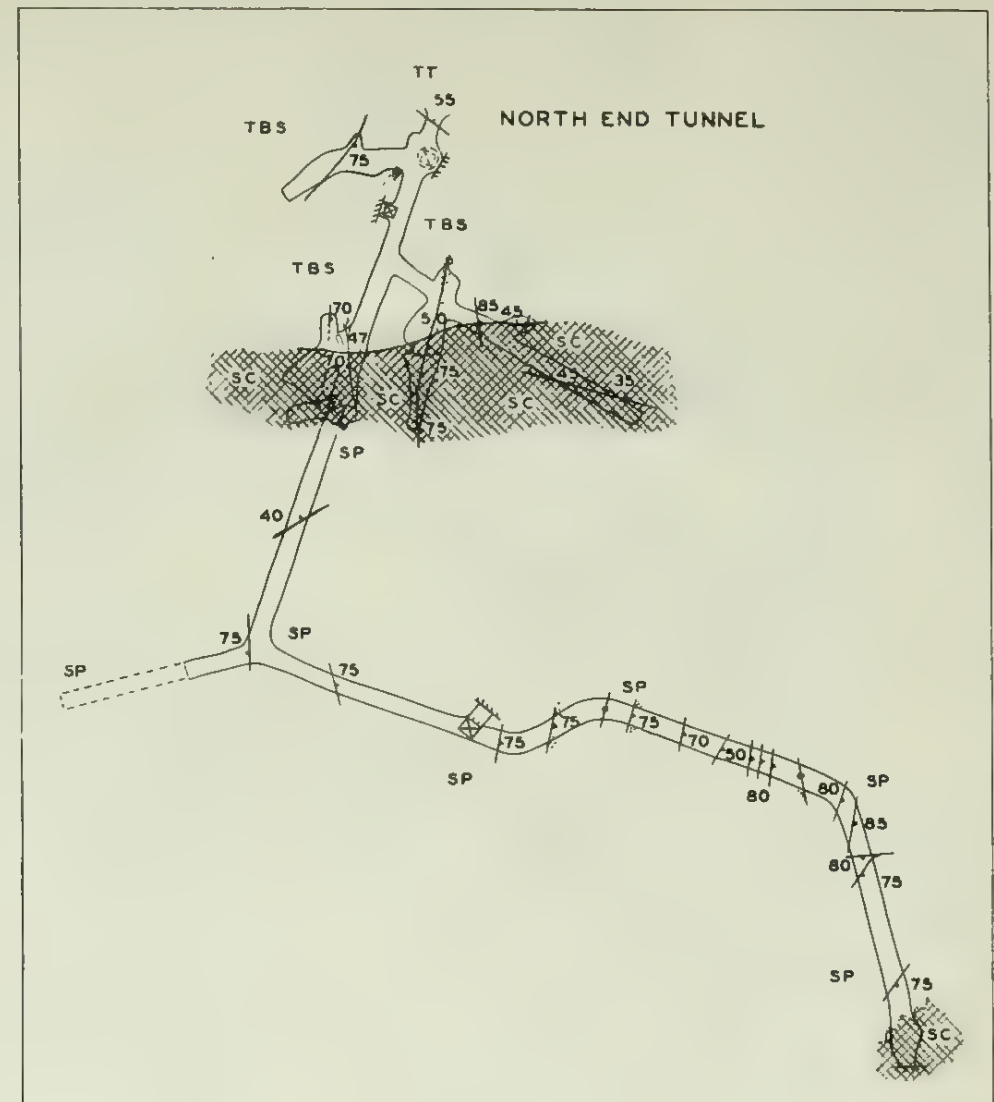
The ore in the Manhattan area occurs as small irregular veins filling joint cracks in the volcanic rocks, and as local areas of disseminated cinnabar in the volcanic rocks adjoining the veins. The most productive veins have been in basalt or silicified tuff, but a few have been worked in the softer, unsilicified tuff where some additional ore occurred along bedding planes. The veins are nearly vertical and at most localities strike N. 10°-30° E. None of them are persistent either in length or depth, and as a result, the surface production has come from many widely distributed open pits.

¹⁷ Ransome, A. L., and Kellogg, J. L., Quicksilver resources of California: California Div. Mines Rept. 35, table 2, p. 360, 1939.

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	SILICA-CARBONATE ROCK		HEAD OF INCLINED OPENING
	TUFF (SILICIFIED)		
	BASALT		FOOT OF INCLINED OPENING
	TUFF		
	SERPENTINE		HEAD OF INCLINED OPENING AT SURFACE
	CINNABAR MINERALIZATION		
	FAULT		APPROXIMATE POSITION OF CAVED UNDERGROUND VERTICAL SHAFT
	CONTACT		
	GRADATIONAL CONTACT		
	JOINTS & SHEAR PLANES		INACCESSIBLE WORKINGS
	MINERALIZED WITH QUARTZ DOLOMITE		
	MARCASITE & SMALL AMOUNTS OF STIBNITE		



25 0 25 50 75 100

SCALE IN FEET

SEPT 1943

BRUNTON & TAPE SURVEY OF WORKINGS & GEOLOGY
BY PAUL AVERITT & G DONALD EBERLEIN
U.S. GEOLOGICAL SURVEY

The most interesting pit is the San Quentin glory hole, which is made up of several interconnected quarries cut into a small hill of silicified tuff. Numerous small parallel vertical veins were mined here by tunnels and stopes that extend short distances laterally from the bottom of the pits, and by shallow shafts sunk in the floor of the pits.

The other pits in the area, all of which are in altered lava or partly silicified tuff, have slumped somewhat since abandonment, and yield little information on the nature of the ore occurrence. The north-northeast-trending pit a short distance north of the San Quentin hill, however, is reported by Forstner¹⁸ to have contained a vein 1 to 4 feet wide and 200 feet long that extended downward 50 to 60 feet in basalt. East-south-east of this pit another vein striking more nearly north was mined by shaft and open cut. The basalt in this pit was 130 feet thick and underlain by tuff. Exploration below the basalt failed to yield any considerable amounts of ore. The most productive pit on the property is said to have been the one immediately south of the Johnstown shaft. Here the ore occurred in both altered basalt and tuff. A shaft was sunk 200 feet near this pit, and according to Forstner¹⁹ penetrated "mudrock" at depth, and ended in lava. No ore was found below the "mudrock", which, presumably, is the same zone that crops out in the nearby creek bottom at the Jamestown shaft.

In the past most of the underground work on the property was concentrated in a zone of interbedded basalt and partly silicified tuff under the basalt-covered ridge northeast of the San Quentin pits. Here the strike of the tuff and of the basalt-tuff contacts is approximately N. 30° W., and the dip is approximately 50° SW. Most of the old stopes were driven along joint planes striking N. 10°-20° E., parallel to the major joint direction on the property, and dipping 75° W. The ore occurs both along the joints and along steeply dipping bedding planes in the tuff. The deepest part of these workings is not more than 200 feet below the surface.

In 1940 and '41 underground development was being carried out in the North-End tunnels at the extreme northern corner of the mineralized area where a basalt dike approximately 50 feet thick has been intruded between serpentine and fine-grained tuff. The dike, which locally thickens to the northwest, dips 45°-55° NE. Silica-carbonate rock and a mineralized zone containing cinnabar mark the contact between the basalt and the underlying serpentine. The presence of serpentine fairly high on the west side of the hill in which the North-End tunnels are driven suggests that the serpentine and the tuff were in fault contact before the intrusion of the basalt dike. Inasmuch as the major fault between the Knoxville formation on the east and serpentine on the west passes beneath this point, the apparent displacement of the tuff can be interpreted as the result of minor movements that occurred during and after volcanic action.

The North-End tunnel area has been thoroughly explored by two adits (see Pls. VI and X). Small amounts of cinnabar have been obtained from small N. 25° E. trending veins in the volcanic rocks and, to a very minor extent, in the serpentine. The basalt-serpentine contact, from which a small amount of ore was recovered, is mineralized with both cinnabar and stibnite (Sb_2S_3).

¹⁸ Forstner, Wm., The quicksilver resources of California: California Min. Bur. Bull. 27, p. 86, 1903.

¹⁹ Idem. p. 84.

The ore obtained in this area was burned in a 25-ton rotary furnace that was erected on the east side of the main ridge between the two adits. Approximately 2,500 tons of ore were treated in this operation, but the yield in quicksilver was disappointing and work was abandoned in July 1941. The furnace subsequently was taken out of the district. During the rest of 1941, '42, and '43, random prospecting was carried out by the two lessees, Charles Wilson, and Wm. M. Hickox, who operated a 1-tube retort at the site of the Johnstown shaft.

Although the Manhattan mine has produced a considerable quantity of quicksilver during its history, it is notable that all the ore has occurred in veins of small vertical and horizontal extent. Furthermore, the underground prospecting that has been carried out has, without exception, shown no significant mineralization in the lower part of the volcanic section. If there is any deep-seated mineralization it probably occurs in the Franciscan-Knoxville fault zone that underlies the volcanic rocks, although the fact that quicksilver deposits rarely have a vertical extent of more than a few hundred feet weighs against this possibility. Moreover, the results of operations in this fault zone in the northern part of the property were economically unsuccessful. One unimportant place that has not been explored is the northwestern extension of the Franciscan-Knoxville fault under the basalt cap. As some small production has been obtained in the Harrison mine to the northwest on the same fault, it follows that the area underneath the flow may be favorable ground for exploration although surface indications on the edges of the flow are not encouraging. The best means of exploration and development in this area would be by power shovel, which could be used to cut long prospect trenches normal to the strike of the mineralized joints in the volcanic rocks. A power shovel would also be useful in stripping the hillside between the two North-End adits where a number of small veins were observed.

In a final analysis, the type of development that was being carried out in the area in 1943, in which ore was obtained from small surface cuts, hand sorted, and burned in a retort, is in keeping with the character of the mineralization, and when the price of quicksilver is high, may be expected to yield several flasks per month.

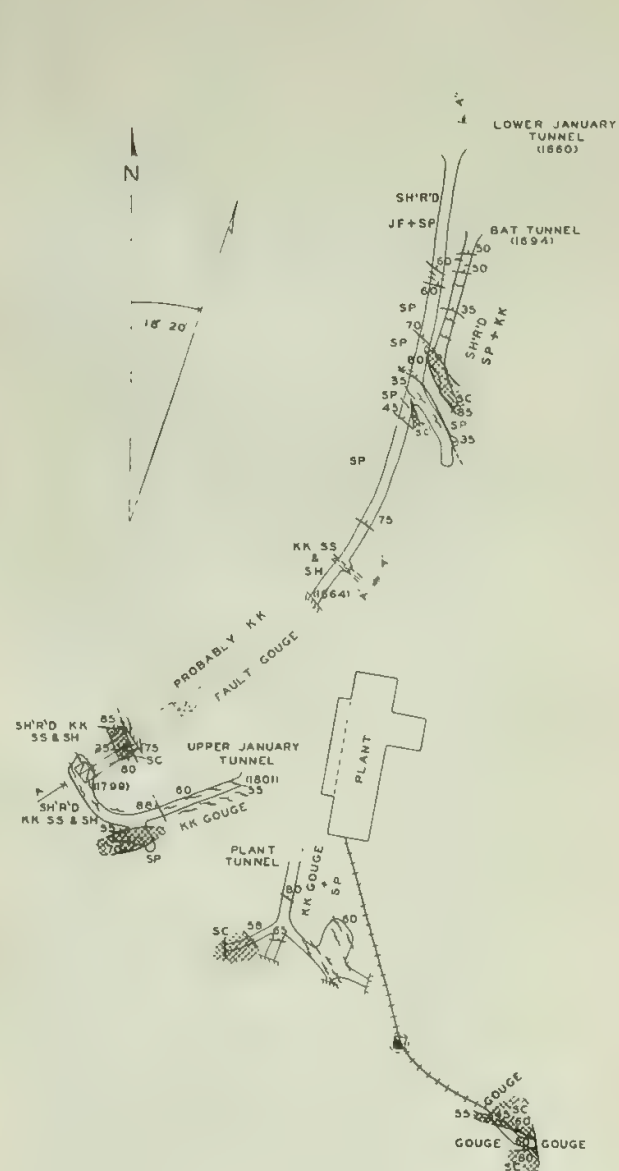
Harrison Mine

The Harrison mine is a short distance northwest of the Manhattan mine in sec. 35, T. 12 N., R. 5 W., M. D. It is owned by Verne and Vince Harrison and in the fall of 1943 was leased to H. C. Scott. The mine formerly was known as the January and Ruby mine, and the property also includes the old New England claim, which lies in sec. 26. Becker²⁰ described these deposits under the name Grizzly claim.

The Harrison mine lies on a broad fault zone between serpentine and the Knoxville formation. This fault zone, which strikes N. 42° W. and dips steeply northeast, is several hundred feet wide in the vicinity of the mine. Contained in this zone are large linear masses of greenstone of the Franciscan formation, sandstone of the Knoxville formation, and highly sheared serpentine. Smaller masses of silica-carbonate rock are present locally, but none of these have any considerable horizontal or

²⁰ Becker, G. F., *Geology of the quicksilver deposits of the Pacific slope*: U. S. Geol. Survey Mon. 13, p. 283, 1888. (Atlas)

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BASE MAP SUPPLIED BY H C SMITH
GEOLOGY & ADDITIONAL WORKINGS BY PAUL AVERITT & G DONALD EBERLEIN
U S GEOLOGICAL SURVEY



HARRISON MINE YOLO COUNTY, CALIFORNIA

25 0 25 50 75 100
SCALE IN FEET

DATUM IS APPROXIMATELY MEAN SEA LEVEL
SEPT 1943

EXPLANATION

	SILICA-CARBONATE ROCK		HEAD OF INCLINED OPENING
	SERPENTINE		APPROXIMATE POSITION OF FOOT OF INCLINED OPENING
	KNOXVILLE FORMATION SH SHALE		APPROXIMATE POSITION OF CAVED SHAFT AT SURFACE
	SS SANDSTONE		TRACK
	FRANCISCAN FORMATION		INACCESSIBLE WORKINGS
	CINNABAR MINERALIZATION		BUILDING
	FAULT (DASHED WHERE INFERRED)		LINE OF SECTION
	LINEATION OF SHEARS IN FAULT ZONE		
	GRADATIONAL CONTACT		

PHYSICAL
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vertical extent. Cinnabar, in association with pyrite, calcite, and bituminous material, occurs as veins and local disseminations in the silica-carbonate rock.

Between 1940 and 1943 the property was leased by several different individuals, all of whom confined their activities in and above the old workings. A rotary furnace capable of handling 30 tons of ore per day was in position throughout this interval, but it was in operation only for a few brief periods.

As shown on Plate XI, the mine consists of four adits and several hundred feet of workings. Most of these formerly were connected by a central vertical shaft about 125 feet deep, but this caved during the winter of 1940-'41. Plate VI also shows the size and distribution of silica-carbonate rock masses in the fault zone. In general, it will be noted that these are too small and too widely distributed to permit large-scale operations. However, they contain small quantities of ore, some of which is visible in the winze in the Upper January tunnel, and also in the short, southernmost adit.

Although neither the surface nor underground geology suggests that the Harrison mine is capable of yielding ore in commercial quantities, the production from the property was 263 flasks in 1917, '18, and '19, when the price of quicksilver was approximately \$100 per flask, and it is possible that it may yet be made to yield some small amounts of quicksilver.

Soda Springs Prospect

The Soda Springs prospect is on the Harrison mine property in sec. 36, a short distance northeast of the Harrison mine. The prospect consists of a single outcrop of silica-carbonate rock in Knoxville strata (see Pl. VIII). This is in alignment with a similar outcrop to the northwest in sec. 26 and the two are thought to lie on a minor fault in the Knoxville formation. The Soda Springs outcrop has been extensively prospected and three small veins of cinnabar are exposed in the workings. The ore was burned in the Harrison furnace, but recovery was small. In view of the limited size of the silicified zone it is unlikely that any considerable production will be obtained in the future.

The outcrop of silica-carbonate rock that lies in sec. 26 northwest of the Soda Springs workings has also been extensively prospected, but there is no evidence that ore was discovered.

Reed Mine

The Reed mining property includes all of the mineralized zone extending diagonally across secs. 23, 25, and 26 of T. 12 N., R. 5 W., M. D. (see Pl. VI). The old Andalusia mine and Fusiyaami tunnel are at the northwest end of this zone, and the California or Reed mine is at the southeast end. All of these workings are now consolidated under the ownership and management of the Bradley Mining Company of San Francisco. Until the last few years the only important production from this property was obtained between 1870 and 1880 when nearly 10,000 flasks were produced (see table 1). Beginning in 1940 the war-time stimulation of quicksilver prices made possible a new and carefully planned development program, and during 1941, '42, and '43 the Reed mine was the leading producer in the Knoxville district. A 4-foot rotary

furnace with a capacity of 40 to 45 tons was installed early in 1942, and the production of 2422 flasks for the year was the largest the property has ever attained.

The mine lies on a northwest-trending fault which brings serpentine on the southwest against the Knoxville formation on the northeast. The fault in general dips steeply to the southwest. It is marked by a well-defined gouge zone which locally contains several large linear masses of greenstone of the Franciscan formation. Silica-carbonate rock, formed by the hydrothermal alteration of serpentine, is the host rock for the cinnabar deposits. It occurs both along the edge of the serpentine mass, and in separate blocks in the gouge zone. The silica-carbonate zone ranges between 0 and 100 feet in width, and extends a little more than one mile along the fault. The full length of the outcrop, which is on a steep hillside several hundred feet above the level of Davis Creek, has been explored either by the early prospectors, or by a series of recent power-shovel cuts, and in the fall of 1943 stripping operations were still in progress at the extreme northwest end of the zone.

In the past, underground work in the mineralized zone was concentrated between the outcrop and the level of Davis Creek. The present Reed mine, however, is being developed at or below the level of the creek. The geology on the main level of the mine workings, which is approximately at the level of Davis Creek, is shown on Plate XII. At the southeast end of the workings the southwest-dipping silica-carbonate rock lies between two gouge zones. The main footwall gouge separates the silica-carbonate rock from the Knoxville formation and is 4 or 5 feet thick. It contains fragments of serpentine, veins of calcite and dolomite, small masses and stringers of silica-carbonate rock, and a small amount of cinnabar. Most of the ore shoots in the mine occur in the silica-carbonate rock near this gouge. The hanging-wall gouge, which, at the south end of the mine is composed of highly sheared Knoxville strata, lies between silica-carbonate rock and serpentine and is 1 to 3 feet thick. Typically it contains sheared serpentine and granular silica-carbonate rock, both heavily mineralized with pyrite and marcasite. This gouge zone cuts diagonally across the silica-carbonate rock and joins the footwall gouge. The contact between silica-carbonate rock and serpentine continues, however, as a crushed zone of sulphides along which evidence of movement grows progressively less to the northwest. Both the hanging-wall and footwall faults are broken by a cross fault at the southeast end of the workings, and the hanging-wall fault is broken in several places by small cross faults that do not break the footwall fault.

The major movement on all faults occurred before silicification of the serpentine, and the gouge zones thus formed were factors in localizing movements of the silica-bearing solutions. After silicification, minor movements produced systems of fractures in the brittle silica-carbonate rock, and in the crushed zone at the contact between silica-carbonate rock and serpentine. Crushed sulphides and slickensided cinnabar along the hanging-wall gouge zone show that some mineralization occurred during this final movement, but most of the ore was deposited at the conclusion of the movements, for no orebodies have been observed to be offset by faulting.

The ore mineral is primarily cinnabar²¹ which occurs as small veins and local disseminations in the silica-carbonate rock, and to a limited extent in the gouge. Iron sulphides are very abundant, and bituminous matter in the form of a light green oil occurs in amounts averaging several gallons per ton of ore. Calcite and dolomite are present in small quantities.

Most of the ore shoots in the mine lie in silica-carbonate rock adjoining the footwall gouge. Here ore deposition was controlled by minor reversals in dip of the nearly vertical gouge from the normal southwest direction to the northeast. These reversals produced local hanging walls against which precipitation took place. This type of structure is illustrated by section A-A' on Plate XII, which shows the relations where good ore occurred on the lowest level of the mine below the 223 winze. This area, as will be noted, is favorable for exploration over a vertical distance of approximately 100 feet and a horizontal distance of 100 to 150 feet. The southeast end of the workings (section D-D') ore occurred in silica-carbonate rock adjoining the gouge zone on the main cross fault, which apparently terminates mineralization to the southeast. The structural control in this part of the mine is similar to that in the 223 winze area. Other ore shoots were localized near cross faults in the hanging-wall drift, as in the 217 stope. Still others were controlled by fracture zones ending between the hanging-wall and footwall faults.

During 1942 and '43 exploration was undertaken to determine the extent of mineralization northwestward in the mine, and the drift on the main level was extended on the footwall gouge as shown on Plate XII. It was found that both the amount of ore and thickness of the silica-carbonate "ledge" decreases to the northwest. This drift was abandoned, and surface cuts were made along the outcrop northwest of existing workings. These revealed only small isolated masses of silica-carbonate rock in the fault zone and but a small amount of low-grade surface ore was uncovered. Meanwhile, the Upper Reed tunnel (see Pl. XIII) was opened to test the ore possibilities of the northwest end of the mineralized zone at depth, but the results were disappointing and the drift was temporarily abandoned. It is noteworthy, however, that the gouge zone is quite thick in the drift, and that small quantities of good ore were discovered. Moreover, the workings at the northwest end of the drift are only a few hundred feet below and a few hundred feet southeast of the clearing outcrop of silica-carbonate rock at the extreme northwest end of the mineralized zone. Extension of the workings in the tunnel to the northwest, therefore seems to be desirable.

In general, four areas on the property appear to have better than average possibilities of yielding ore. The best of these is the structure shown on section A-A', which can be reached from the lowest level of the mine. Almost as attractive is the ore-bearing outcrop of silica-carbonate rock at the extreme northwest end of the mineralized zone where stripping operations were in progress in the fall of 1943. This area can be explored at depth by extending the workings in the Upper Reed tunnel a few hundred feet to the northwest. Further development is recommended in the 202 winze area to test the ore possibilities of the hanging-wall gouge at the southeast end of the mine.

²¹ Early production from the Reed mine was largely from metacinnabar. W. W. Evans, *California Div. Mines Bull.* 78, p. 205.

Because of the difficulty of obtaining labor the Reed mine has been unable to carry out extensive development work. It is therefore impossible to estimate the reserve tonnage of ore in precise terms. In view of the output of the mine in 1942 and '43, however, and the known quality of the ore in various workings, it can be stated with some confidence that the mine is capable of yielding 1,500 to 2,000 flasks a year for several years, when the price is at or near \$200 a flask.

Red Elephant Mine

The Red Elephant mine lies on the western edge of the Knoxville district in sec. 3, T. 11 N., R. 5 W. The mineralized area is a narrow belt of silica-carbonate rock along a northwest-trending shear zone in serpentine. Nearby are dike-shaped masses of olivine basalt similar in composition and appearance to the Tertiary basalt flows elsewhere in the district.

The shear zone, which is about two miles long, includes several isolated masses of Franciscan rocks, and half a mile northwest of the mine another small body of silica-carbonate rock crops out. In the mine, as shown on Plate XIV, the shear zone strikes west of north and dips northeast at an angle of 45° . The trend of the zone on the surface, however, suggests that the dip is nearly vertical, and it is possible that the connections between the silicified areas and the Franciscan masses are more apparent than real. The shear zone in the mine is marked by 1 to 3 feet of clay gouge in highly sheared serpentine. Silicification, which is general on the surface in the area shown on Plate VI, is noticeable underground only in occasional stringers, and the ore, for the most part, is in veins in unaltered serpentine. These ore-bearing veins follow N. 70° W.-trending joints, which apparently are confined to the east side of the shear zone. Tunnels 1 to 7 follow the course of these veins. The gouge along the shear zone is black with finely disseminated iron sulphide and is said to contain enough cinnabar to mine in most places. However, no ore has been removed from this zone because of difficulty in mining.

Cinnabar is the most important ore mineral, although native mercury occurs in appreciable quantities. Pyrite, marcasite, calcite, and dolomite are the principal gangue minerals.

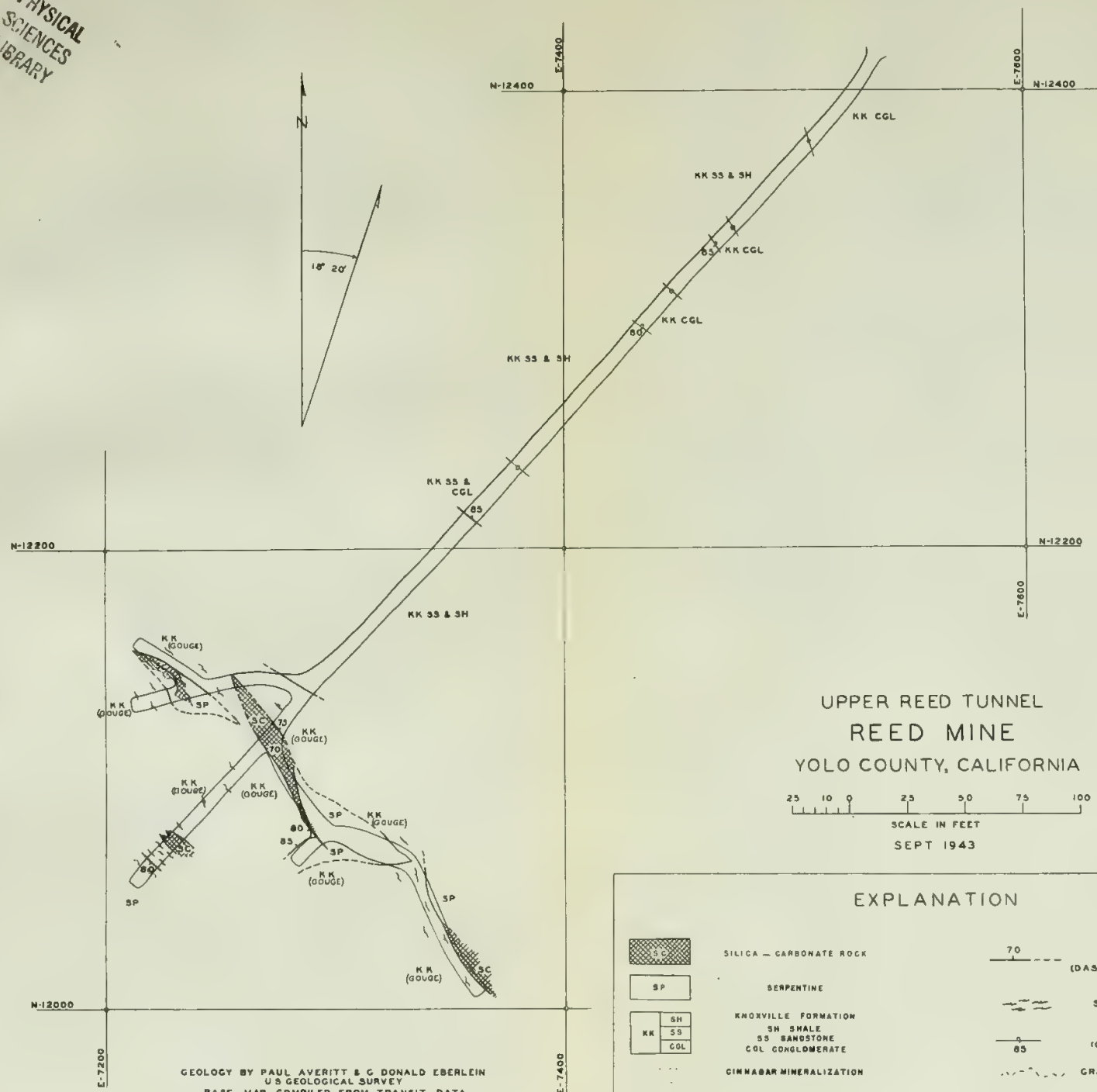
The Red Elephant mine has been worked at two different periods in the past (see table 1) and was reopened in the fall of 1941. A new ton rotary furnace was installed, and a new inclined shaft, the southernmost one on Plate XIV, was sunk. A small amount of development work was carried out during 1942 along the shear zone south of the former workings. This work was not profitable, however, and the mine was abandoned during the winter of 1942-43. Subsequently all the equipment was taken out of the district. When the mine was revisited in September 1944 the new shaft and all the workings were flooded.

The mineralized zone at the Red Elephant mine is too small to start a full-scale mining venture, but it does contain small amounts of ore, and at some future date the property may yield a small amount of cinnabar-silver.

Miscellaneous Prospects

The Knoxville district contains several other areas of silica-carbonate rock, which have been prospected, but which have yielded no appreciable

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UPPER REED TUNNEL
REED MINE
YOLO COUNTY, CALIFORNIA

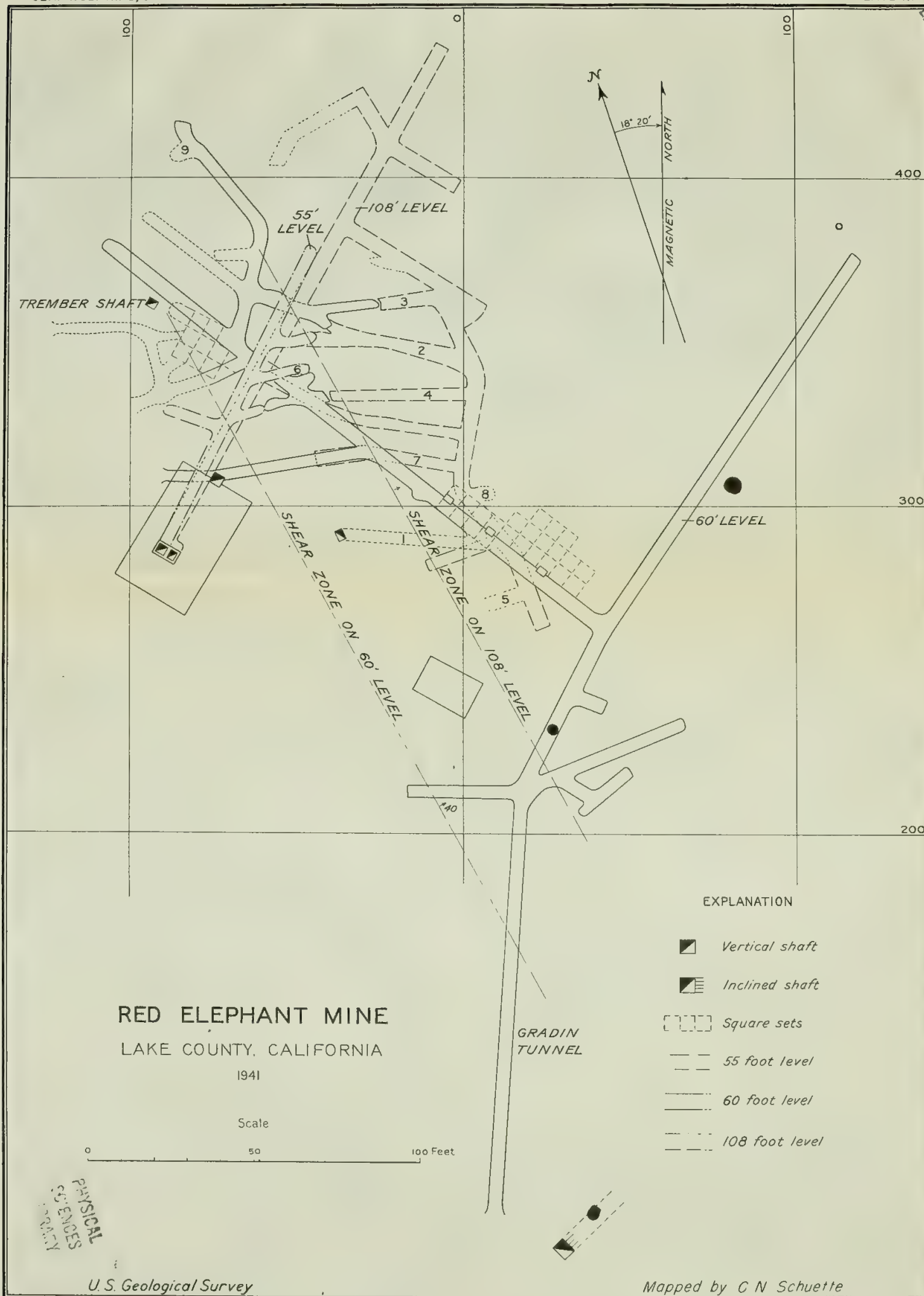
25 10 0 25 50 75 100
SCALE IN FEET
SEPT 1943

EXPLANATION

	SILICA - CARBONATE ROCK		70 --- FAULT (DASHED WHERE INFERRED)
	SERPENTINE		SHEARING TREND
	KNOXVILLE FORMATION		CONTACT (OVERTURNED BEDS)
	SH SHALE		GRADATIONAL CONTACT
	SS SANDSTONE		
	CGL CONGLOMERATE		
	GINNABAR MINERALIZATION		

GEOLOGY BY PAUL AVERITT & G. DONALD EBERLEIN
U.S. GEOLOGICAL SURVEY
BASE MAP COMPILED FROM TRANSIT DATA
SUPPLIED BY THE BRADLEY MINING CO

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quantities of ore. All these are small and unworthy of further attention. The area in the NE $\frac{1}{4}$ sec. 10, T. 11 N., R. 5 W., is the largest of the silica-carbonate zones in this category. Others are present in the SW $\frac{1}{4}$ sec. 34, T. 12 N., R. 5 W., and in the E $\frac{1}{2}$ sec. 29, T. 12 N., R. 5 W.

FUTURE POSSIBILITIES AND RESERVES

Mining activity in the Knoxville district is predicated upon a relatively high price for quicksilver, and it is unlikely that the production rate established between 1941 and 1944 can be maintained during periods of normal economy. It is apparent, however, that the district is capable of yielding on the order of 2,000 flasks a year for several years, if operations are carried out on the scale witnessed during 1942 and 1943.

SPECIAL ARTICLES

UNEXPECTED USE TRANSFORMS OUTLOOK FOR QUICKSILVER *

By H. H. WANDERS **

The amazing performance of the quicksilver market during the war period stands out boldly in an otherwise well-regimented price situation. In fact, there has been sufficient action in quicksilver prices since 1939 to start a first-class witch hunt by those unfamiliar with the peculiar problems of the industry. Actually, there is no mystery about the metal's wide price swings and the production record.

Early in the war period the price advanced sharply because it was thought that domestic production would have to carry the full weight of an enlarged war program. The price jumped from \$88 per flask of 76 lbs. as war broke out all over Europe in 1939, to \$200 as 1941 ended. The Office of Price Administration stepped in early in February 1942 and set a ceiling price that was only slightly below the top figure that obtained in the United States market. Those who favored a high ceiling believed that a generous price would have to prevail to bring out the metal in quantity.

High prices lifted production. Output of quicksilver in 1939 amounted to 18,600 flasks. Four years later (1943) production climbed to 52,000 flasks, the highest annual rate attained since 1882. Peak production in this country was 79,400 flasks in 1877, and the low was 6,340 flasks in 1921.

Up to the middle of 1944 the war demands for quicksilver failed to come up to expectations, and supplies accumulated. The price turned weak and moved downward over the first half of 1944, touching \$97 per flask, New York, in June of that year, about \$100 per flask below the ceiling level. The price was well on its way to the prewar level when buying interest suddenly appeared, and some highly optimistic estimates on probable requirements were mentioned in market circles. A new use was responsible for the unexpected change. The market advanced to \$140 per flask before 1944 ended.

The mysterious new source of quicksilver consumption turned out to be a small mercury oxide dry cell developed for the Army for use in the tropics, and big things are claimed for the new cell. It possesses long shelf life, about five times that of the common dry cell, and stands up under such trying operating conditions as heat and high humidity. Makers say the cell delivers a constant voltage until exhausted.

Construction is along radically different lines from those employed in making the common dry cell. The components are red oxide of mercury, a thin ribbon of zinc, specially prepared paper, and a steel container. The zinc and paper, along with the oxide, are rolled into a spiral to fit into the container. The cell is hermetically sealed. Initial production centered in a cell about the size of a dime in diameter and three-eighths of an inch high. A radio battery constructed for the Signal Corps, rated at 93.6 volts, contained 72 of these tiny cells and weighed two pounds.

* Reprinted from *Engineering and Mining Journal* for May 1945, vol. 146, no. 5, p. 80.

** Market Editor.

Some observers contended that the new use will absorb more of the metal than any other classification heretofore accepted as an important outlet for quicksilver. Unless the battery program is cut back for one reason or another, demand for quicksilver over the remainder of 1945 will increase to a point where augmented domestic production and large importations will be needed to meet the requirements. One of four plants now producing the dry cell went on record early this year with a statement to the effect that the Signal Corps has required the company "to quadruple its production."

To expand domestic production without obtaining a clear picture of what lies ahead presents a puzzling problem for domestic mine operators. The price has risen sufficiently in recent months to revive marginal production. However, absence of official word on the size and duration of the battery program, together with some uncertainty about other outlets for the metal, tends to make producers think twice before expanding output.

Early this year the price appeared to be marching right back to the ceiling level, with sellers asking from \$167 to \$172 per flask, New York. Attractive prices brought out larger offerings from foreign producers. First there was Canadian metal, then Mexican, and finally Spanish quicksilver. When Spanish metal was sold for March shipment from abroad at \$155 per flask, duty paid, New York, various domestic producers raised the cry of "dumping." Later, April shipment quicksilver was offered by Spanish interests at \$152.

Experts insist that consumption of quicksilver in 1945 will be substantially higher than in recent years, owing to the new use for the metal, and the price for the current year will average well above the 1944 level.

Quicksilver statistics

	U. S. production (a)	Price, N. Y., per flask (b)
1939 -----	18,633	\$103.94
1940 -----	37,777	176.87
1941 -----	44,921	185.02
1942 -----	50,844	196.35
1943 -----	51,924	195.21
1944:		
January -----	4,400	151.60
February -----	3,800	130.00
March -----	3,800	130.00
April -----	3,700	128.00
May -----	3,400	115.54
June -----	3,000	101.69
July -----	2,700	100.56
August -----	2,500	104.04
September -----	2,500	104.28
October -----	2,700	109.20
November -----	2,300	116.30
December -----	2,500	128.88
	37,300	(c) 118.36
1945:		
January -----	2,500	156.85
February* -----	2,700	165.55
March* -----	3,000	162.00

(a) In flasks of 76 lb. Estimated by Bureau of Mines.

(b) E. & M. J. averages.

(c) Average for 1944.

* February and March figures supplied by Walter W. Bradley, State Division of Mines.

STEEL

THE STORY OF STEEL IN THE WEST AND POSSIBILITIES FOR ITS FUTURE DEVELOPMENT*

By WILLIAM H. POBERT **

The steel industry in the western part of the United States had its beginning soon after the early pioneers settled and began business. The first attempt to roll iron in the West was made in San Francisco in 1868, which involved only small uses. About 1875, the first iron rails were rolled for western railroads. Six years later steel was rolled from blooms imported from England. The cable street car system of San Francisco could only be built if the steel cables were woven locally, on account of the inability to transport the huge reels through the Rocky Mountain tunnels. The mining machinery for the California placer mining for the 49'ers gold was often cast in nearby foundries. So from a humble beginning the steel industry in the West has grown to considerable proportions.

In its initial stage, the manufacture of steel requires three different raw materials—iron ore, limestone and coal for making coke. It is not usual to find sufficient quantity of all of these materials of satisfactory quality in any one region in the United States to make it profitable to construct suitable steel works, and at the same time be near the available markets. When the material is of low grade, or when long transportation is involved, the project is unprofitable. In the West the widely distributed population and the distance of hauling makes the steel industry a very interesting and unusual problem.

The growing use of steel is one of the most fascinating industrial studies of the day. While we think of the present war as an engineer's war, steel is used in almost every form of modern warfare. A single item of gasoline drums made in the West for shipment to the Pacific would be counted into the millions. Steel bath tubs were once objectionable but not today. Steel beds are substituted for wooden beds and California Housing Authorities require them. Steel office furniture has become standard. Automobiles, if built today of material other than steel, could hardly be sold. It would be much easier to make a list of every-day household articles and things we see every day which are not made of steel than those made of steel.

In some industries in the earlier days, it was possible to single out an individual who persisted and was responsible for its conception and development, such as John D. Rockefeller in the oil, and Henry Ford in the automobile industry. Today it is not possible to name an individual who was responsible for a large amount of the development of the steel industry. But, many of our Western engineers have had much to do with the development of the Western steel industry through the use of steel in construction work. Many of the Western civil and structural engineers have been responsible for the conception and design of Western skeleton steel-frame office buildings, steel bridges and steel-frame industrial plants.

One of the Western steel industries is the Columbia Steel Company, a California-born subsidiary of the United States Steel Corporation. It is a decided factor in the Western steel industry with its

* Reprinted from *California (Alumni) Monthly*, for April 1945.

** Public Relations Division, Columbia Steel Company.

facilities and resources, with its great diversity of production, and as a participant in the war effort. With producing facilities located at Pittsburg, California, another plant at Torrance, California, and iron and coal mines, a blast furnace and coke plant in Utah, plus complete warehousing facilities and sales offices in the principal Pacific Coast cities, Columbia is an integrated steel producer.

The Columbia Steel Company made its start in 1910 at Pittsburg, California, with a single basic open hearth furnace that had a capacity of 15 tons per heat. One of its principal promoters was Wiggington E. Creed, who was also greatly interested in the development of gold mining in California with the use of dredgers. At first, the chief purpose of the steel plant was for making castings for gold dredgers and other mining machinery, for lumbering and the shipping industry.

From the modest beginning, the Pittsburg plant has grown to such proportions that it now occupies 400 acres. It has expanded from one little foundry and one 15-ton furnace to the present two large foundries and more than a dozen furnaces, five of which have a capacity of more than 80 tons each. There are more than twenty other buildings, including a rod mill, wire and nail mill (the only nail mill on the Pacific Coast), wire-rope mill, sheet mill, rolling mill, electric furnace, shops, warehouses, testing laboratories and offices.

The latest addition to the plant is the new foundry costing six million dollars, built by the Government for war purposes on a 43-acre tract nearby. It is ultra modern with every possible mechanical convenience, and it is generally conceded to be one of the most modern foundries in America.

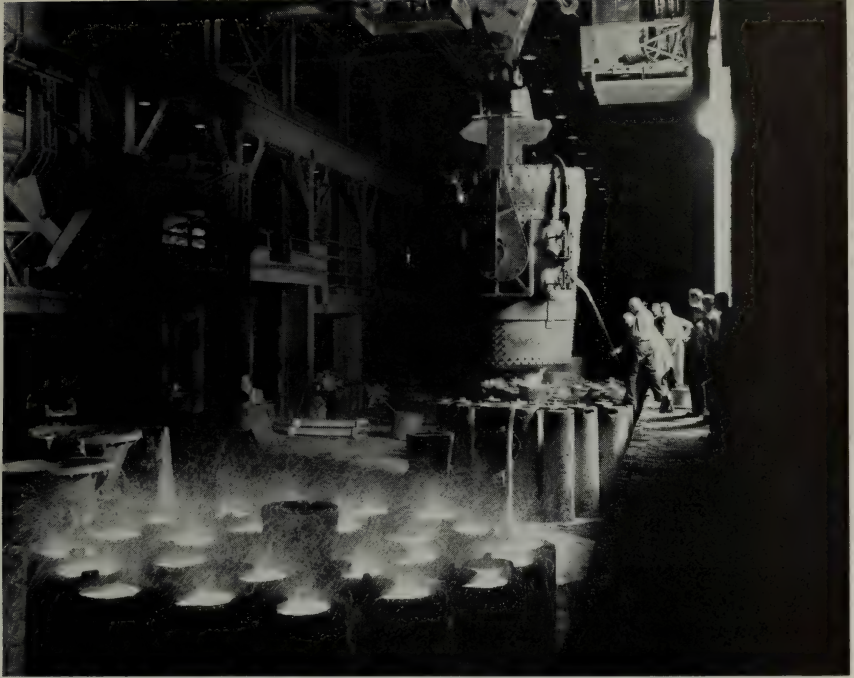
Complete details of the scientific operations and mechanical marvels of this modern steel mill would require a volume for a complete description. Just a few items: In the rod mill a 600-pound billet of steel 30 feet long and $2\frac{1}{2}$ inches square comes from the furnace white hot and in less than a minute is converted into bundles of wire rod each nearly a mile long, traveling through the rolls like fiery snakes at high speed. In the nail mill, of a total of 1400 varieties of nails in the world, 1200 are made here, ranging from 8-inch spikes to tiny nails two-thirds of an inch long, produced in quantities as many as 600 per minute. In the foundries, 30,000-pound anchors are cast, as are also the heavy hull castings for warships and merchant vessels. The wire-rope mill manufactures cables for San Francisco's cable cars, and wire rope for elevators, ship hawsers, airplane control wire and for many other uses.

"The Rolls Royce of the Steel Industry" is what the *Iron Age* names the United States Government owned Geneva Steel Plant, often described as the most modern in the world. Located beneath snow-capped mountains beside Utah Lake, it is an hour's drive south of Salt Lake City.

* * *

Another important steel manufacturer is the Bethlehem Steel Company with three Pacific Coast plants located at Seattle, San Francisco, and Los Angeles. * * *

Bethlehem's South San Francisco plant was originally operated under the name of Pacific Coast Steel Company. It has been said that it was built to take advantage of the steel scrap available after the 1906 earthquake. Steel making facilities have been increased to three 56-ton and one 50-ton furnaces with an annual ingot capacity of 157,000 tons.



SCENE IN THE OPEN-HEARTH DEPARTMENT OF COLUMBIA STEEL COMPANY'S PITTSBURG, CALIFORNIA, WORKS, AFTER MOLTEN STEEL FROM AN OPEN-HEARTH FURNACE HAS BEEN POURED INTO A LADLE

The above operation shows the molten steel being poured through a master runner into ingot molds. After the molten steel has solidified and contracted, the molds will be stripped from the ingots. *Photo by courtesy of Department of Public Relations, Columbia Steel Company.*



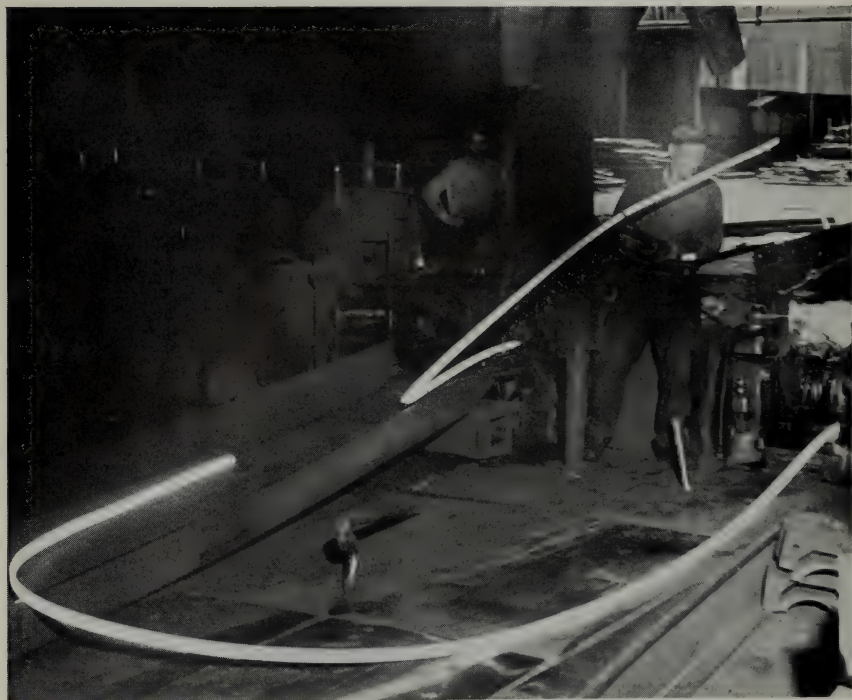
SHIPMENT OF NAVY STOCKLESS ANCHORS FROM COLUMBIA STEEL COMPANY'S NEW FOUNDRY AT PITTSBURG, CALIFORNIA

Eight carloads of these huge grapplers, which weigh 30,000 pounds each, were moved from this U. S. Steel plant recently for service with the Navy. *Photo by courtesy of Department of Public Relations, Columbia Steel Company.*



STERN FRAME FOR MERCHANT SHIP, LOADED UPON FLAT CAR FOR DELIVERY TO WEST COAST SHIPYARD

This huge casting was produced at the Pittsburg, California, works of Columbia Steel Company. *Photo by courtesy of Department of Public Relations, Columbia Steel Company.*



STRANDER WITH TONGS SHOWN ENTERING A WHITE HOT BAR INTO A SET OF FINISHING ROLLS (RIGHT) IN THE 12-INCH MERCHANT MILL AT PITTSBURGH, CALIFORNIA, WORKS

Safety "pins" in the floor plates protect the worker from the hot bars. *Photo by courtesy of Department of Public Relations, Columbia Steel Company.*



WORKMAN OPENING AND SHEARING HOT ROLLED SHEETS AT COLUMBIA
STEEL COMPANY TORRANCE PLANT

*Photo by "Dick" Whittington. Courtesy Department of Public Relations, Columbia
Steel Company.*



TURNING OUT NAILS AT THE RATE OF 390 A MINUTE ON EACH MACHINE, IN THE WEST COAST'S ONLY MANUFACTURING PLANT (PITTSBURG, CALIFORNIA) WHICH OPERATES 189 NAIL-MAKING MACHINES

This battery of automatic nail machines performs five distinct functions: feeding the wire, forming the head, pinching the wire, cutting the wire and forming the point, and expelling the finished nail. *Photo by courtesy of Department of Public Relations, Columbia Steel Company.*



A, A BENCH IN OPEN-PIT OF VULCAN IRON MINE OF KAISER COMPANY, INC.,
NEAR KELSO, SAN BERNARDINO COUNTY

*Photo by Walter W. Bradley; reprinted from California Journal of Mines and Geology
for October 1943, page 472.*



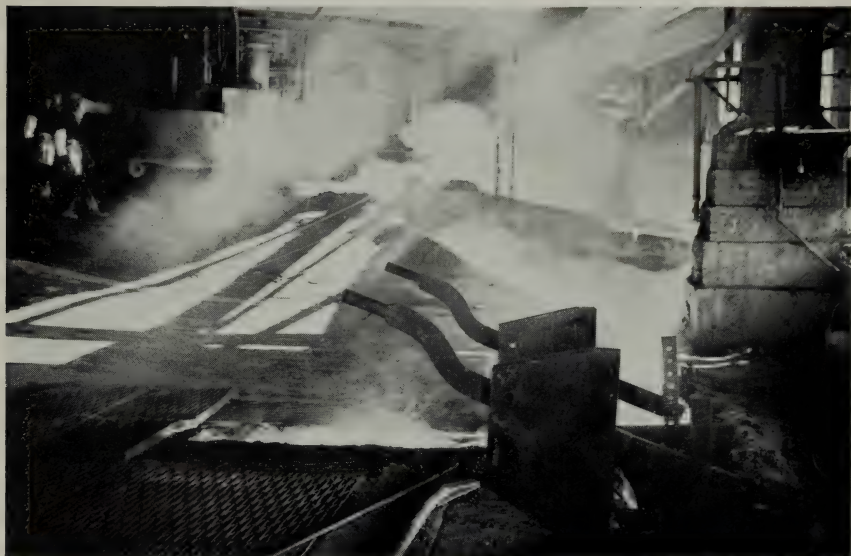
B, ORE-BIN AND TRUCK-LOADING BELT AT VULCAN IRON MINE, NEAR
KELSO, SAN BERNARDINO COUNTY

*Photo by Walter W. Bradley; reprinted from California Journal of Mines and Geology
for October 1943, page 472.*



A, IRON ORE AND FLUX (CLAY AND LIMESTONE) STOCKPILE AT KAISER COMPANY, INC., STEEL PLANT AT FONTANA, SAN BERNARDINO COUNTY

Photo by Walter W. Bradley; reprinted from California Journal of Mines and Geology for October 1943, page 466.



B, TAPPING THE BLAST FURNACE AT FONTANA PLANT OF KAISER COMPANY, INC., SAN BERNARDINO COUNTY

Photo by Walter W. Bradley; reprinted from California Journal of Mines and Geology for October 1943, page 466.

Concrete reinforcing bars are bent to customers' specifications. The bolt and nut department, which manufactures bolts, nuts, spikes, etc., is the largest of its kind west of the Mississippi. The Tower Fabricating Shop is one of the few in this country devoted entirely to steel tower fabrication, and is the largest on the Pacific Coast.

Bethlehem's Los Angeles plant was originally located in the heart of Los Angeles in the early 1880's. In the first open-hearth furnace constructed in 1914, the pig iron was imported from China. Today, there are three 50-ton furnaces with an annual ingot capacity of 112,000 tons. About 95% of the scrap charged into these furnaces is obtained from the Los Angeles area. Here are rolled structural angles and reinforcing bars, merchant bars and special sections. The bolt and nut plant has been increased in capacity until it now produces 11,000 tons per year. In the Forge Department, the principal products are alloy drill collars and kelly bars shaped in a 1000 ton press.

The Bethlehem Steel Company also maintains fabricating works, shipbuilding yards, ship repair yards and general sales offices on this Coast.

The newest steel plant in the West is that of the Kaiser Company, Incorporated, at Fontana in Southern California. Work was begun on April 6, 1942, and eight months later on December 13, a modern blast furnace started operations. Iron ore is obtained from eastern San Bernardino County, coal from Utah and limestone from a quarry less than ten miles away. There are six open-hearth furnaces with a capacity of 675,000 tons of steel ingots annually, which are sold commercially or sent to the Rolling Mill to be rolled into plates, structural steel and bars. In the Plate Mill, a single ingot can be rolled into a plate 110 inches wide and 50 feet long. In addition to the Plate Mill, there is a 36-inch break-down 28-inch structural mill operating on the same principle as the Plate Mill, but producing structural steel. A 14-inch Merchant Mill also produces shapes and bars from carbon and high-alloy steels. Plates, structural steel, shapes and bars can be made to meet almost any specifications desired by industry.

In addition to the steel ingots already mentioned, the Kaiser Steel Mill is capable of producing 378,000 tons of coke for use in blast furnace in making pig iron, 432,000 tons of pig iron for general sale or refining into steel, 300,000 tons sheared plates, 90,000 tons angles, channels and beams, and 82,000 tons of bars and small shapes. In addition to the steel products, there are capacities for producing 3,768,000 gallons of creosote oil for wood protection and seal, 9,120 tons of ammonium sulphate for fertilizer, 428,000 gallons toluol for manufacturing TNT and other explosives, and many other by-products. In addition to the Iron and Steel Division of the Kaiser Company, there are shipyards and other large industries which are directly or indirectly associated with the development of the Western steel industry.

One of the younger builders of the Western steel industry is Edward L. Soulé, founder and president of the Soulé Steel Company, with headquarters in San Francisco and branch offices and warehouses in the principal Pacific Coast cities. He was the first Western manufacturer to engage in the fabrication and field installation of steel reinforcing bars in large concrete construction projects. He has been engaged in various types of steel product manufacturing and devised the Soulé Steel Joist and Soulé Steel Framing for Prefabricated steel house construction.

* * *

Steel houses, or "Steel in Housing" should be mentioned as a Western accomplishment, for at one time there was more activity in promotion and actual building along these lines in the West than in any other part of the country, if not in the world. Renewed attention is now being given to prefabricated housing, requiring a large amount of steel, or of steel in combination with other materials. It is conservatively estimated that the housing demand in the United States is 10,000,000 houses during the next ten years, in addition to the tens of thousands that will be required in the newly-known islands across the ocean to the west of us, during the next few years.

In order to evaluate the relationship of the Western steel industry, to the University of California and its graduates, the writer has assumed two hypothetical questions and has attempted answers without endeavoring to present too factual information or be too scientific.

Question 1: What of the future of the Western steel industry?

Answer: The steel industry is in its infancy. The total steel requirements or consumption, in pre-war days, for the Pacific Coast, was 50 per cent more than the Pacific Coast steel mill capacity and for every ton actually produced in the West, there were two and one-half tons shipped in from the East. The present steel producing capacity in the eleven Western states has almost doubled (85% to be exact) over pre-war days. During World War II, many new uses for steel have been developed. New combinations of steel with plastic materials have not yet been placed on the market, and manufacturing processes have been vastly improved, which will make steel and its alloys in greater demand than ever before. While the future of the Western steel industry will be largely governed by competition and free trade, we must not overlook the initiative ability of the Western man, and the unknown possibility of trade with the people living in the islands of the Pacific and the countries bordering on the far side of the Pacific ocean. There is every reason to believe that the Western steel industry will enjoy a steady increase in volume for many years.

Question 2: What are the opportunities in the Western steel industry for the California graduate returning from the armed services and for future University graduates?

Answer: There is an unlimited field for them in the industry today, with increased opportunities in the future.

A few years ago, steel making was often determined by an individual who glanced at a cold sample of the "heat" and decided when it should be removed from the furnace. Today it's different, for science and technology enter into the picture, and many carefully educated scientists are constantly on hand to produce the best possible material, uniform in character, and manufactured under ideal conditions. There is a growing demand for Geologists, Metallurgists, Mechanical Engineers, Industrial Engineers, Laboratory Technicians, Research Specialists, Structural Engineers, Sales Engineers, Market Research Engineers and many other trained men and women, who are on the lookout for new supplies of raw materials, discovering improved methods, harmonizing the various processes, discovering new uses, and developing new markets.

Steel—the backbone of the world—has strengthened the West of the past. Now with its new steel making facilities, the West will become ever stronger.

MINERAL EXHIBIT AND STATISTICS

MINERAL STATISTICS FOR 1944

By HENRY H. SYMONS *

INTRODUCTION

The counties of California have produced for some years past more than 50 different mineral substances, the total value of which was estimated at \$451,553,000 for the year 1944. (See California Journal of Mines and Geology for January 1945.)

At present, reports for most of the producers are at hand. Substances for which complete data are now compiled are summarized in this report. There was no record of commercial production during 1944 of bismuth, calcium silicate, graphite, nickel, onyx and travertine, serpentine, shale oil, sulphur, or zircon sand. There was a single producer each of bituminous rock, cadmium, fluorspar, lithia, marble, mica, molybdenum ore, potash, pyrite, slate, titanium, and tin.

BORATES

During the year, there was produced in California a total of 276,398 net tons of borate material, as compared with 249,523 tons for the preceding year. The material shipped during the year included the sodium borates, kernite (rasorite), kramerite from Kern County; also crystallized borax prepared by evaporation of brines at Searles Lake in San Bernardino County and Owens Lake in Inyo County, and a small amount of colemanite from Death Valley, Inyo County.

As the crude ore is not sold as such but is almost entirely refined into borax of commerce before shipping, and because of the fact that the material varied widely in boric acid content, the tonnage has been recalculated to a basis of 40 percent A.B.A. This is approximately the average A.B.A. content of colemanite material after calcining, and also of the crystallized borax obtained from evaporation of the lake brines.

Recalculated, the 1944 output totaled 234,860 net tons, valued at \$5,264,864, as compared with 216,687 tons worth \$4,953,174 for the year 1943. The above came from two properties each in Inyo and San Bernardino Counties, and one in Kern County.

CEMENT

During 1944 the production of cement in California totaled 14,599,752 barrels, valued at \$21,249,520 f.o.b. plant, of which 6,509,279 barrels, worth \$9,103,749, came from six northern California mills, and 8,090,473 barrels, worth \$12,145,726, came from six southern California mills. The 1944 output was a decrease in both amount and value from that of 1943, which amounted to 18,515,085 barrels valued at \$27,865,466.

Shipments of cement during 1944 were made from thirteen mills in eleven counties to the extent of 14,947,713 barrels, valued at \$22,482,794

* Statistician and Curator, Division of Mines. Manuscript submitted for publication May 9, 1945.

f.o.b. plant, as compared with 17,804,421 barrels, worth \$27,500,347 in 1943. During the year seven mills operated in northern California; one each in Calaveras, Contra Costa, Merced, San Benito, San Mateo, Santa Clara, and Santa Cruz Counties, which shipped a total of 6,779,987 barrels, valued at \$10,211,086; and six mills in southern California; three in San Bernardino County and one each in Kern, Los Angeles, and Riverside Counties, which shipped a total of 8,167,726 barrels, valued at \$12,271,708.

A mill in San Bernardino County which has been idle for several years resumed production during the year, also a small shipment of cement was made from the mill in San Benito County which discontinued operation in 1943. The mill in Merced County was sold and the company is being liquidated.

The annual capacity of the California cement mills according to the U. S. Bureau of Mines was 27,390,000 barrels as of January 1, 1945, as compared with 27,690,000 barrels for January 1, 1944. During the year an average of 2,379 men were employed in the above mills.

GYPSUM

Shipments of gypsum in California during 1944 amounted to 558,488 net tons, valued at \$949,833, and came from four properties in Kern County; two each in Imperial and Ventura Counties; and one in Riverside County. The 1944 output was an increase in amount and value as compared with 475,967 net tons, worth \$916,883 in 1943. In addition to the above figures a considerable amount of gypsum came from Alameda County, which was obtained in a chemical process for reducing magnesium salts from salt-works bittern water with lime, the amount of which was not included in the above figures as it was used with lime and magnesite. The 1944 figures showed the largest annual output ever reported in this State. Gypsum mined in this State was used in the manufacture of hard-wall and other plasters, in cement, and for agricultural purposes. The increase in recent years in the uses of this material is chiefly in the agricultural field, the tonnage for which now exceeds that for industrial and structural plasters, and that used in cement.

IRON ORE

The iron ore shipped in California during 1944 totaled 905,981 net tons, valued at \$2,360,694 f.o.b. mine, and came from one property each in San Bernardino, Santa Cruz, and Shasta Counties. The above figures showed a slight decrease in amount with an increase in value as compared with the 1943 output of 907,458 net tons, worth \$2,341,827.

The ore mined during the year was hematite from San Bernardino County which went to the new steel plant at Fontana and was also used in the manufacture of high-iron cement; magnetite from Shasta County and magnetite sands from Santa Cruz County, both used as aggregate in heavy concrete for ballast.

QUICKSILVER

The production of quicksilver in California during 1944 totaled 28,097 flasks, valued at \$3,178,969 f.o.b. mine, and came from 63 properties

in 14 counties; as compared with 33,948 flasks, worth \$6,177,159 in 1943. The 1943 and 1944 outputs, distributed by counties were as follows:

California quicksilver production, 1943 and 1944

County	1943		1944	
	Flasks 76 lbs.	Value	Flasks 76 lbs.	Value
Fresno -----	32	\$5,930	-----	-----
Lake -----	4,206	774,813	3,781	\$430,317
Napa -----	2,023	363,017	1,176	128,570
San Luis Obispo -----	2,625	478,442	921	104,760
Santa Clara -----	1,736	322,871	*	*
Sonoma -----	4,121	761,654	*	*
Colusa, Contra Costa, Del Norte, Inyo, Kings, Monterey, San Benito, Santa Barbara, Siskiyou, Trinity, Yolo *	19,205	3,470,432	-----	-----
Contra Costa, Del Norte, Inyo, Mono, Monterey, San Benito, Santa Barbara, Santa Clara, Sonoma, Trinity, Yolo *	-----	-----	22,219	2,515,452
TOTALS -----	33,948	\$6,177,159	28,097	\$3,178,969

* Combined to conceal the production of individual operators in each.

The 1943 output of quicksilver had the highest annual value recorded in the past 93 years in which a record had been kept of its production in California, and was the largest in amount since 1883. The 1944 California production was the largest of any State in the United States and was approximately 75 percent of the national yield. During 1944 the average New York quotation on quicksilver was \$118.36 per 76-pound flask, while the average amount received by the California miner was \$113.14 per 76-pound flask; as compared with the 1943 average New York quotation of \$195.21 per 76-pound flask and the average price of \$181.96 paid to the California miner.

SALT

Most of the salt production in California is obtained by evaporation of water of the Pacific Ocean, plants being located on the shores of San Francisco, Monterey, and San Diego bays, and at Long Beach. Additional amounts are derived from lakes and lake beds in the desert regions (in part, rock salt), mainly in Imperial, Kern, and San Bernardino Counties, and evaporation of alkaline lake water in Modoc County. A small amount of valuable medicinal salt has been obtained by evaporation of the water of Lake Mono, Mono County, and from a mineral spring in Butte County.

The 1944 salt production in California totaled 769,873 net tons, valued at \$2,060,960, and came from three properties in Alameda County; two in San Bernardino County; and one each in Imperial, Kern, Los Angeles, Monterey, Orange, and San Diego Counties. The 1944 salt output was the largest annual yield ever reported in this State. The figures for 1943 were 631,776 tons worth \$1,695,231. The average value reported by salt producers in California in 1944 was \$2.68 per net ton, f.o.b. plant compared with \$2.68 in 1943; \$2.90 in 1942; \$2.72 in 1941; \$2.79 in 1940; \$2.75 in 1939; \$2.78 in 1938; and \$2.82 in 1937.

SILICA (Sand and Quartz)

The output of silica (quartz and glass sand) in California during 1944 amounted to 274,291 net tons, valued at \$830,311 f.o.b. rail shipping point, and came from three properties in San Bernardino County; and one each in Contra Costa, Mariposa, Monterey, and Riverside Counties. The above figures represent the largest annual output of silica ever reported in this State. The 1943 shipments totaled 161,318 tons, worth \$533,434.

Of the 1944 production, 41,796 tons, worth \$146,582, was quartz, and/or ganister and came from properties in Mariposa and San Bernardino Counties; the remaining 232,495 tons, worth \$683,729, was glass and silica sand and came from Contra Costa, Monterey, Riverside, and San Bernardino Counties.

SOAPSTONE AND TALC

The total production of tale, pyrophyllite, and soapstone in California during 1944 amounted to 64,041 net tons, valued at \$824,052; compared with 63,012 tons, worth \$723,056, in 1943. The 1944 output was the largest annual production ever reported in this State and was 63,796 net tons of high-grade tale and pyrophyllite. The tale came from five properties each in Inyo and San Bernardino Counties and the pyrophyllite from a single property in Mono County. The production of 272 tons of soapstone came from a single property in Amador and Tuolumne Counties.

The tale and pyrophyllite mined during the year were used in toilet powder, cosmetics, paint, paper, rubber manufacture, and a carrier for insecticides, in delousing powder, in cotton finishing, in ceramics, steatite products, etc. The "soapstone" grades were used in metal workers crayons and as a carrier for insecticides.

SODA

The production of sodium salts in California in 1944 included soda ash, and trona, from plants at Owens Lake, Inyo County; and soda ash, salt cake, and trona (sequi-carbonate, a double salt of Na_2CO_3 and NaHCO_3) from Searles Lake, San Bernardino County. The plant on Dale Lake near Amboy and Searles Lake, San Bernardino County, started operations during the year 1940 and made shipments of salt cake in 1941. There were no shipments of salt cake (sulphate) from Carrizo Plains, San Luis Obispo County. Shipments made during the year 1944 totaled 299,574 net tons valued at \$3,647,630 as compared with 260,590 tons worth \$3,166,576 in 1943. The 1944 output had the largest amount and value of any annual production reported in this State. In 1944 179,621 tons of soda ash and 119,953 tons of salt cake were reported shipped in California.

The soda ash was used mainly in the manufacture of soap, glass, paper, oil refining, sugar refining, and chemicals; and the trona for metallurgical purposes. The salt cake or sodium sulphate was used in the manufacture of paper, glass, and in chemicals.

ACCESSIONS TO THE EXHIBIT

By HENRY H. SYMONS *

The museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of economic and academic value. It ranks among the first five such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

The exhibit is daily visited by service men, engineers, students, business men and prospectors as well as tourists and sightseers. In addition to its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the Division of Mines, as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the exhibit are the following:

- 21188 MARBLE from Vaughan marble quarry, near Cadiz, San Bernardino County. Donor: Vaughan Marble Quarry, February 1945. In case 225.
- 21189 VIVIANITE, $\text{Fe}_3\text{P}_2\text{O}_8 \cdot 8\text{H}_2\text{O}$, replacement of tooth of extinct elephant. Found in gold-bearing gravel in Alaska. Donor: J. M. Hill, February 1945. In case 143.
- 21190 KAMMERERITE (pink) and UVAROVITE (green) in chromite from Peg Leg chromite mine, 14 miles southwest of Yreka, Siskiyou County. Donor: Frank Howard, c/o Abbott Hanks, 624 Sacramento St., San Francisco. In case 137.
- 21191 MANGANESE ORE high-grade average shipment 50% Mn from Knutte mine, Novato, Marin County. Donor: J. K. McGrath, U. S. Coast Guard, February 1945. In case 214.
- 21192 AXINITE an aluminum calcium borosilicate with iron and magnesium. From Sheppard Canyon 14 miles west of Ballarat on east slope of Argus Range, Inyo County. Donor: Eugene A. Bacchi, March 1945. In case 132.
- 21193 SEMI-OPAL (fluoresces brilliant green). From Sheppard Canyon, Inyo County. Donor: Eugene A. Bacchi, March 1945. In case 806 (Fluorescence).
- 21194 TEKTITE of meteoritic origin. From Luzon near Manila, Philippine Islands. Donor: H. Foster Bain, March 1945. In case 103.

* Statistician and Curator, Division of Mines. Manuscript submitted for publication May 9, 1945.

LIBRARY

LIBRARY REPORT

By JAMES M. LITTLE *

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INTRODUCTION

The library of the Division of Mines contains more than 6,000 selected volumes on mines, mining, and allied subjects. It is also the repository for reports and bulletins of technical departments of Federal and State governments and educational institutions both domestic and foreign. Current copies of newspapers published in the mining centers of the State are also available for reference.

The library and reading room are open to the public during the usual hours, when the librarian may be freely called upon for all necessary assistance.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY AND UNITED STATES BUREAU OF MINES

The library of the Division of Mines has available for public reference the following publications of the United States Geological Survey: Annual Reports, Monographs, Professional Papers, Bulletins, Water-Supply Papers, Mineral Resources, Folios of the Geologic Atlas of the United States (broken file), Maps with Descriptive Text (broken file), Administrative Publications (broken file); and the following publications of the United States Bureau of Mines: Bulletins, Technical Papers, Economic Papers (broken file), Mineral Resources of the United States, Monographs (broken file), Reports of Investigations, Information Circulars.

Reports, mainly on California, recently received from the Bureau of Mines include:

United States Bureau of Mines

Bulletin

460 Diatomites of the Pacific Northwest as Filter-Aids.

Information Circulars

7299 Bureau of Mines Exploration of Mercury. Deposits to June 30, 1944.

7315 A Pattern for Western Steel Production.

* Librarian, Division of Mines.

PUBLICATIONS OF STATE SURVEYS

A broken file of mining and geological publications, issued by the organizations listed below, may be consulted in the library of the Division of Mines.

Alabama Geological Survey, University.
 Alaska (Territorial Commissioner of Mines), Juneau
 Arizona Bureau of Mines, Tucson.
 Arkansas Geological Survey, Little Rock.
 Colorado Bureau of Mines, Denver.
 Connecticut Geological and Natural History Survey, Hartford.
 Florida Department of Conservation, Tallahassee.
 Georgia Division of Geology, Atlanta.
 Idaho Bureau of Mines and Geology, Moscow.
 Idaho Inspector of Mines, Boise.
 Illinois Geological Survey, Urbana.
 Indiana Division of Geology, Indianapolis.
 Iowa Geological Survey, Des Moines.
 State Geological Survey of Kansas, Lawrence.
 Kentucky Geological Survey, Frankfort.
 Louisiana Department of Conservation, New Orleans.
 Maine State Geologist, Augusta.
 Maryland Geological Survey, Baltimore.
 Michigan Geological Survey, Lansing.
 Minnesota Geological Survey, Minneapolis.
 Mississippi State Geological Survey, University.
 Missouri Bureau of Geology and Mines, Rolla.
 Montana Bureau of Mines and Geology, Butte.
 Nebraska Geological Survey, Lincoln.
 Nevada State Bureau of Mines, Reno.
 New Jersey Department of Conservation and Development, Trenton.
 New Mexico Bureau of Mines and Mineral Resources, Socorro.
 New York Science Division, Albany.
 North Carolina Geological and Economic Survey, Chapel Hill.
 North Dakota Geological Survey, Grand Forks.
 Ohio Geological Survey, Columbus.
 Oklahoma Geological Survey, Norman.
 Oregon State Department of Geology and Mineral Industries, Portland.
 Pennsylvania Topographic and Geological Survey, Harrisburg.
 South Dakota State Geological Survey, Vermillion.
 Tennessee Division of Geology, Nashville.
 Texas Bureau of Economic Geology, Austin.
 Virginia Geological Survey, University.
 Washington State Department of Conservation and Development, Pullman.
 West Virginia Geological Survey, Morgantown.
 Wisconsin Geological and Natural History Survey, Madison.
 Wyoming Geological Survey, Cheyenne.

PUBLICATIONS OF FOREIGN GOVERNMENTS

Publications of the following departments of foreign governments are received and current issues may be consulted in the library. Earlier issues of foreign-language publications have been loaned to the California Academy of Sciences in Golden Gate Park, because of the limited storage space at the Divisions' offices in the Ferry Building. They may, however, be consulted at the Academy.

Alberta Research Council, Edmonton.
 Argentina Direccion General de Minas y Geologica, Buenos Aires.
 British Columbia Minister of Mines, Victoria.
 British Museum and Natural History, London.
 Canada Department of Mines, Ottawa.
 Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
 Direccion General de Minas y Petroleo, Mexico City.

Direction of Mines, Dakar, French West Africa.
 Geological Service of Minas Geraes, Bella Horizonte, Brazil.
 Geological Survey of Canada, Ottawa.
 Geological Survey of Scotland.
 Instituto Historica e Geographico Rio de Janeiro.
 Museo de Historia Natural de Montevideo, Uruguay.
 Museu Nacional, Rio de Janeiro.
 New South Wales Department of Mines, Sydney, Australia.
 New Zealand Geological Survey Branch, Wellington.
 Nova Scotia Department of Public Works and Mines, Halifax.
 Ontario Department of Mines, Toronto, Canada.
 Quebec Bureau of Mines, Quebec.
 Queensland Department of Mines, Brisbane, Australia.
 Service of Mines, Brazzaville, French Equatorial Africa.
 South Australia Department of Mines, Adelaide.
 Transvaal Chamber of Mines, Johannesburg, South Africa.
 Western Australia Geological Survey, Perth.

PUBLICATIONS OF FOREIGN AND DOMESTIC SOCIETIES AND EDUCATIONAL INSTITUTIONS

Academia de Ciencias y Artes de Barcelona, Spain.
 Academy of Natural Sciences of Philadelphia.
 American Association of Petroleum Geologists, Tulsa, Oklahoma.
 American Geographical Society of New York.
 American Institute of Mining and Metallurgical Engineers, New York.
 American Journal of Science, New Haven, Conn.
 American Philosophical Society, Philadelphia.
 Australian Museum, Sydney.
 California Academy of Sciences, San Francisco.
 Canadian Institute of Mining and Metallurgy, Montreal.
 Carnegie Institution of Washington.
 Cleveland Museum of Natural History, Cleveland, Ohio.
 Colorado College Publications, Colorado Springs.
 Colorado Scientific Society, Denver.
 Commonwealth Club, San Francisco.
 Economic Geology, Lancaster, Penn.
 Field Museum of Natural History, Chicago.
 Franklin Institute of the State of Pennsylvania, Lancaster.
 Geological Society of America, Columbia University, New York.
 Geographical Society of London.
 Institution of Mining and Metallurgy, London.
 Instituto de Mineralogia y Geologia, Universidad de Tucuman, Argentina.
 Instituto Geologico de Mexico, Mexico, D. F.
 Journal of Geology, Chicago.
 Mineralogical Society of America, Menasha, Wisconsin.
 Michigan College of Mining and Technology, Houghton.
 Mining and Metallurgical Society of America, New York.
 Missouri School of Mines and Metallurgy, Rolla.
 National Research Council, Washington, D. C.
 New York Academy of Sciences, New York.
 New York State Museum, Albany.
 Pennsylvania State College, State College.
 Philippine Journal of Science, Manila.
 Royal Society of South Australia, Adelaide.
 Seismological Society of America, Stanford University.
 Sierra Club, San Francisco.
 Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
 Southern California Academy of Sciences, Los Angeles.
 Stanford University, Palo Alto, California.
 University of California Publications in Engineering, Geography, and Geology, Berkeley.
 University of California Publications in Geography, Berkeley.
 University of California Publications in Geology, Berkeley.
 University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

CURRENT MAGAZINES

Current issues of the technical magazines listed below are on file in the reading room of the library, and may be consulted.

Asbestos, Philadelphia, Pennsylvania.
 Brick and Clay Record, Chicago.
 California Magazine of the Pacific, San Francisco.
 California Mining Journal, Auburn.
 California Oil World, Los Angeles.
 California Safety News, San Francisco.
 Canadian Mining Journal, Gardenvale, Quebec.
 Chemical and Metallurgical Engineering, New York City.
 Chemical Engineering and Mining Review, Melbourne, Australia.
 Civil Engineering, New York City.
 Colorado School of Mines, Golden, Colorado.
 Engineering and Mining Journal, New York City.
 Fusion Facts, Whittier, California.
 Gold, Toronto, Canada.
 Grizzly Bear, Los Angeles.
 Hercules Mixer, Wilmington, Delaware.
 Independent Monthly, Tulsa, Oklahoma.
 Lubrication, The Texas Co., New York City.
 Metals and Alloys, Pittsburgh, Pennsylvania.
 Mining and Contracting Review, Salt Lake City.
 Mineralogist, Portland, Oregon.
 Mining Congress Journal, Washington, D. C.
 Mining and Industrial News, San Francisco.
 Mining and Geological Journal, Melbourne, Victoria, Australia.
 Mining Journal, London.
 Mining Journal, Phoenix, Arizona.
 Mining and Metallurgy, New York City.
 Mining World, Seattle.
 Nickel Steel Topics, New York City.
 Northwest Mining News, Spokane, Washington.
 Oil and Gas Journal, Tulsa, Oklahoma.
 Oil, Paint and Drug Reporter, New York City.
 Oil Weekly, Houston, Texas.
 Pacific Purchaser, San Francisco.
 Petroleum World, Los Angeles.
 Queensland Government Mining Journal, Brisbane, Australia.
 Rock Products, Chicago.
 Rocks and Minerals, Peekskill, New York.
 Scientific American, New York City.
 Southwest Builder and Contractor, Los Angeles.
 Standard Oil Bulletin, San Francisco.
 Stone, New York City.
 Western Mining News, San Francisco.

NEWSPAPERS

Current issues of the following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
 Amador Dispatch, Jackson, California.
 Banner, Sonora, California.
 Barstow Printer, Barstow, California.
 Bridgeport Chronicle-Union, Bridgeport, California.
 Calaveras Californian, Angels Camp, California.
 Calaveras Prospect, San Andreas, California.
 Daily Commercial News, San Francisco, California.
 Del Norte Triplicate, Crescent City, California.
 Denver Mining Record, Denver, Colorado.
 Inyo Independent, Independence, California.
 Inyo Register, Bishop, California.

Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mining Press, Reno, Nevada.
Mohave Miner, Kingman, Arizona.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Oroville Mercury Register, Oroville, California.
Placer Herald, Auburn, California.
Placerville Times, Placerville, California.
Plumas Independent, Quincy, California.
Randsburg Times, Randsburg, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Weekly Trinity Journal, Weaverville, California.
Yreka Journal, Yreka, California.

NEW BOOKS

- Addicks, L., Silver in Industry, 636 pp., Reinhold Publishing Co., New York, 1940.
Berkman, S., Catalysis, Inorganic and Organic, 1130 pp., Reinhold Publishing Co., New York, 1940.
Briggs, H. E., An Encyclopedia of Gems, 83 pp., Gemological Institute of America, Los Angeles, 1944. (F. W. Bradley Memorial Book Fund.)
Burns, R. M., and Schuh, A. E., Protective Coatings for Metals, 407 pp., Reinhold Publishing Co., New York, 1939.
Bush, F. B., Reading Engineering Drawings, 60 pp., John Wiley & Sons, New York, 1942. (F. W. Bradley Memorial Book Fund.)
Chowdhury, R. R., Handbook of Mica, 340 pp., Chemical Publishing Co., Brooklyn, 1941. (F. W. Bradley Memorial Book Fund.)
Davis, C. V., Handbook of Applied Hydraulics, 1084 pp., McGraw-Hill Book Co., New York, 1942. (F. W. Bradley Memorial Book Fund.)
Douglas, J., Gold in Placer, 150 pp., published by the author, P.O. Box 878, Oakland, Calif., 1944.
Edwards, J. D., Aluminum Paint and Powder, 216 pp., Reinhold Publishing Co., New York, 1936.
Farrington, S. K., Jr., Railroads at War, 320 pp., Coward McCann, Inc., New York, 1944.
Gemological Institute of America, The Story of Diamonds, 96 pp., Gemological Institute of America, Los Angeles, 1941. (F. W. Bradley Memorial Book Fund.)
Gregg, J. L., Arsenical and Argentiferous Copper, 189 pp., Chemical Catalog Co., New York, 1934.
Gregory, T. C., Uses and Applications of Chemicals and Related Minerals, Vol. 1, 665 pp., Reinhold Publishing Co., New York, 1939.
Gregory, T. C., Uses and Applications of Chemicals and Related Minerals, Vol. 2, 459 pp., Reinhold Publishing Co., New York, 1944.
Hayward, C. R., An Outline of Metallurgical Practice, 690 pp., D. Van Nostrand Co., New York, 1940. (F. W. Bradley Memorial Book Fund.)
Hodgman, C. D., Handbook of Chemistry and Physics, 28th Ed., 2571 pp., Chemical Rubber Publishing Co., Cleveland, Ohio.
Hool, G. A., and Kine, W. S., Reinforced Concrete and Masonry Structures, 2nd Ed., 835 pp., McGraw-Hill Book Co., Inc., New York, 1944.
Hou, T., Manufacture of Soda, 590 pp., Reinhold Publishing Co., New York, 1942.
Kalichevsky, V. A., The Amazing Petroleum Industry, 234 pp., Reinhold Publishing Co., New York, 1943.
Kreps, T. J., The Economics of the Sulfuric Acid Industry, 284 pp., Stanford University Press, Stanford University, 1937. (F. W. Bradley Memorial Book Fund.)
Mantell, C. L., Tin, Its Mining, Production, Technology, and Applications, 366 pp., Chemical Catalog Co., New York, 1929. (F. W. Bradley Memorial Book Fund.)
Merlup-Sobel, M., Metals and Alloys Dictionary, 238 pp., Chemical Publishing Co., Brooklyn, 1944. (F. W. Bradley Memorial Book Fund.)
Musham, H. A., The Technique of the Terrain, 223 pp., Reinhold Publishing Co., New York, 1944. (F. W. Bradley Memorial Book Fund.)
Richardson, H. W., and Mayo, R. S., Practical Tunnel Driving, 1st Ed., 436 pp., McGraw-Hill Book Co., Inc., New York, 1941.

Robinson, C. S., Explosions Their Anatomy and Destructiveness, 87 pp., McGraw-Hill Book Co., Inc., New York, 1944.

Shipley, R. M., Dictionary of Gems and Gemology, 254 pp., Gemological Institute of America, Los Angeles, 1945. (F. W. Bradley Memorial Book Fund.)

Shipley, R. M., Famous Diamonds of the World, 62 pp., Gemological Institute of America, Los Angeles, 1939. (F. W. Bradley Memorial Book Fund.)

Smith, H. G., Figuring with Graphs and Scales, 62 pp., Stanford University Press, Stanford University, 1938. (F. W. Bradley Memorial Book Fund.)

Staley, W. W., Introduction to Mine Surveying, 275 pp., Stanford University Press, Stanford, 1939. (F. W. Bradley Memorial Book Fund.)

Thomas, C. A., Anhydrous Aluminum Chloride in Organic Chemistry, 972 pp., Reinhold Publishing Co., New York, 1941. (F. W. Bradley Memorial Book Fund.)

von Stein, P., Organic Reagents in Inorganic Analysis, 242 pp., Chemical Publishing Co., Brooklyn, 1942. (F. W. Bradley Memorial Book Fund.)

SERVICES OF THE DIVISION OF MINES

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January 1922, and continued until March 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September 1923. For the same reason, beginning with the January 1924 issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January 1933 chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

TYPES OF REPORTS

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g., feldspar).
3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

Reports of District Mining Engineers

In 1919-1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the frontispiece outline map of the State.

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

Special Articles

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

MAIL AND FILES

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

COMMERCIAL MINERAL NOTES

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial

minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of *Commercial Mineral Notes*, and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco 11; State Building, Los Angeles 12; State Office Building No. 1, Sacramento 14; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

Write for latest revised price list.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Report I of the State Mineralogist, 1880, 43 pp. Henry G. Hanks -----	----
**Report II of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks-----	----
**Report III of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks -----	----
**Report IV of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks -----	----
**Report V of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geo- logical map. Henry G. Hanks-----	----
**Report VI of the State Mineralogist, Part 1, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks-----	----
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.-----	----
Price \$0.75, sales tax \$0.02	\$0.77
**Report VII of the State Mineralogist, 1887, 315 pp. William Irelan, Jr. ----	----
**Report VIII of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.-----	----
Report IX of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.-----	Price \$1.15, sales tax \$0.03 1.18
**Report X of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.-----	----
Report XI (First Biennial) of the State Mineralogist, for the two years end- ing September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr. -----	Price \$1.50, sales tax \$0.04 1.54
**Report XII (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford -----	----
**Report XIII (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford -----	----
Chapters of the State Mineralogist's Report XIV, Biennial Period, 1913-1914, Fletcher Hamilton :	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Coun- ties, 172 pp., paper-----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper-----	Price \$0.50, sales tax \$0.01 .51
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Coun- ties, 59 pp., paper-----	Price \$0.35, sales tax \$0.01 .36
Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper-----	Price \$0.75, sales tax \$0.02 .77
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**Report XIV of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915 :	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth -----	----
Chapters of the State Mineralogist's Report XV, Biennial Period, 1915-1916, Fletcher Hamilton :	

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Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper-----	Price \$0.50, sales tax \$0.01 \$0.51
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper-----	
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper-----	
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper-----	
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper-----	
**Report XV of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
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Mines and Mineral Resources of Plumas County, 188 pp., paper-----	Price \$0.50, sales tax \$0.01 .51
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Report XVII of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth-----	Price \$2.50, sales tax \$0.06 2.56
Report XVIII of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
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Chapters of Report XXII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926. Mines and Mineral Resources of Trinity and Santa Cruz Counties-----	
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Chapters of Report XXIX, 1933 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
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July-October, 1942. Contact Metamorphic Rocks of the Twin Lakes Region; Tabulated List of Tungsten Properties; Geology of Welsh Tungsten Prospect, Madera Co.; Tungsten Deposits in Confidence Mining District, Tuolumne Co.; Ghost Canyon Tungsten Claims, Madera Co.; Hot Springs Deposits, Coso Mountains; Biennial Report of State Mineralogist; includes map showing Tungsten Properties in California-----	Price \$1.20, sales tax \$0.03 1.23
Chapters of Report XXXIX, 1943 (quarterly), titled "California Journal of Mines and Geology," containing the following:	
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April, 1943. Manganese Discovery in San Mateo County. Current Activities in Strategic Minerals. Clerbus-Mae Tungsten Prospect, Trinity County. Mylonites of Eastern San Gabriel Mountains. Geology and Tungsten of Sierra Nevada N. E. of Visalia, Tulare County. Geology of San Benito Quadrangle, with map. Lithium. Quartz-----	Price \$0.60, sales tax \$0.02 .62
July, 1943. Carbon Dioxide, Mendocino and Southern Sonoma Counties. Current Activities in Strategic Minerals. Crestmore Minerals. Isometrograph as Developed and Used at New Idria Mine. Sutter (Marysville) Gas Field. Sillimanite Group of Minerals. New Federal and State Legislation -----	Price \$0.60, sales tax \$0.02 .62
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January, 1944. Geology of Palm Springs-Blyth, Riverside County. Geology of Parts of Barstow Quadrangle, San Bernardino County. Geology of Needles-Goffs Region, San Bernardino County. Airox Concrete Aggregate. Marketing Magnesite and Allied Products-----	Price \$0.60, sales tax \$0.02 .62
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Price \$0.15, sales tax \$0.01	.16

Other Maps—Continued

		Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.		
Chromite deposits (showing California geology uncolored)-----	Price \$0.60, sales tax \$0.02	\$0.62
Grass Valley and Nevada City District claim map accompanying report on mines and mineral resources of Nevada Co. in July, 1941, Chapter of Report XXXVII, sold separately-----	Price	.10
Nevada City District Claim Map, accompanying report on mines and mineral resources of Nevada County in July, 1941, Chapter of Report XXXVII, sold separately-----	Price	.10
Nevada County Map, accompanying report on mines and mineral resources of Nevada County in July, 1941, Chapter of Report XXXVII, sold separately-----	Price \$0.15, sales tax \$0.01	.16
Oil and Gas Fields (showing California geology uncolored), accompanying Bulletin 118, sold separately-----	Price \$1.00, sales tax \$0.03	1.03
Index map of Economic Minerals and Geomorphic Provinces-----		Free
Imperial Co. Map, accompanying report on mines and mineral resources of Imperial County in April, 1942, Chapter of Report XXXVIII, sold separately-----	Price	.10
Tungsten Properties in California, accompanying July-October, 1942, Chapter of Report XXXVIII (showing California geology uncolored), sold separately-----	Price \$0.60, sales tax \$0.02	.62
Santa Cruz Co. Map, accompanying report on mines and mineral resources of Santa Cruz County in January, 1943, Chapter of Report XXXIX, sold separately-----	Price \$0.15, sales tax \$0.01	.16
San Benito Quadrangle Geologic Map, accompanying report on geology of area in April, 1943, Chapter of Report XXXIX, sold separately Price \$0.40, sales tax \$0.01		.41
San Bernardino County Map, accompanying report on mines and mineral resources of San Bernardino County in October, 1943, Chapter of Report XXXIX, sold separately-----	Price \$0.15, sales tax \$0.01	.16
Manganese Deposits (showing California geology uncolored), accompany- ing Bulletin 125, sold separately-----	Price \$0.60, sales tax \$0.02	.62

OIL AND GAS FIELD MAPS

The following maps are on sale at the State Division of Oil and Gas, Ferry Building, San Francisco, and the various branch offices. The maps are revised as development work advances and ownerships change. Price includes postage and sales tax.

No.	Price
1—Sargent, Santa Clara County-----	\$0.75
2—Santa Maria, including Cat Canyon—Los Alamos, Santa Barbara County-----	1.25
3—Santa Maria, including Casmalia and Lompoc, Santa Barbara County--	1.25
4—Brea Olinda and East Coyote, Los Angeles, Orange Counties-----	1.25
6—Salt Lake—Beverly Hills, Los Angeles County-----	1.25
7—Sunset, including San Emidio, Kern County-----	1.25
8—South Midway, including Buena Vista Hills, Kern County-----	1.25
9—North Midway and McKittrick, Kern and San Luis Obispo Counties----	1.25
10—South Belridge and McKittrick-Temblor oil fields, Kern County-----	1.25
11—Lost Hills and North Belridge, including Antelope Hills, Kern County---	1.25
12—Devils Den, Kern County-----	1.00
13—Kern River and Kern Front fields, including portion of Poso Creek field, Kern County-----	1.00
14—Coalinga and East Coalinga Extension, Fresno County-----	1.50
15—Elk Hills, Kern County-----	1.25
16—Ventura-Ojai, Ventura County-----	1.25
17—Santa Paula-Ojai, including South Mountain, Ventura County-----	1.25
18—Sespe-Piru-Simi, including Bardsdale, Ventura County-----	1.50
18a—Newhall, Aliso Canyon, Newhall-Potrero, Del Valle and Oak Canyon, Los Angeles County-----	1.25
19—Arroyo Grande, San Luis Obispo County-----	1.00

OIL AND GAS FIELD MAPS—Continued

No.	Price
20—Long Beach, Los Angeles County-----	\$1.75
21B—District 5, boundaries of areas including oil fields, Fresno, Kings and Kern Counties-----	1.00
21C—District 4, boundaries of areas including oil fields, Kern, Kings and Tulare Counties-----	1.25
22—District 3, boundaries of areas including oil fields, Santa Barbara County-----	.75
23—District 2, boundaries of areas including oil fields, Ventura County-----	1.00
24—District 1, boundaries of areas including oil fields, Los Angeles and Orange Counties-----	1.00
26—Huntington Beach, Orange County-----	1.50
27—Santa Fe Springs, Los Angeles County-----	1.25
28—Torrance, Los Angeles County-----	1.25
28a—Townlot area, Torrance field, Los Angeles County-----	.75
29—Dominguez, Los Angeles County-----	1.00
30—Rosecrans, Los Angeles County-----	1.25
31—Inglewood, Los Angeles County-----	1.25
32—Seal Beach, Los Angeles and Orange Counties-----	1.25
33—Rincon, Ventura County-----	1.50
34—Mt. Poso and Poso Creek, Kern County-----	1.00
35—Round Mountain, Kern County-----	1.00
36—Kettleman North Dome and Middle Dome, Fresno and Kings Counties--	1.50
37—Montebello, Los Angeles County-----	1.00
38—Whittier, Los Angeles County-----	1.25
39—West Coyote Oil Field, Los Angeles and Orange Counties-----	1.25
40—Elwood, Goleta (abandoned), La Goleta (gas), Santa Barbara County--	1.25
41—Potrero, Los Angeles County-----	1.00
42—Playa del Rey, Los Angeles County-----	1.50
43—Capitan, Santa Barbara County-----	1.00
44—Mesa, Santa Barbara County-----	1.50
46—Richfield, Orange County-----	1.25
48—Mountain View and Edison, Kern County-----	1.25
49—Fruitvale, Kern County-----	1.00
50—Wilmington, Los Angeles County-----	1.25
51—Santa Maria Valley, Santa Barbara County-----	1.00
52—El Segundo and Lawndale, Los Angeles County-----	1.50
53—Rio Bravo and Greeley, Kern County-----	1.00
54—Wasco oil field, Buttonwillow and Semitropic (gas), Kern County-----	1.25
55—Canal, Canfield Ranch, Coles Levee, Strand, Ten Section, Kern County--	1.25
56—Paloma, Kern County-----	1.25
57—Rio Vista (gas), Sacramento, Solano, and Contra Costa Counties-----	1.00
58—Trico Gas, Kern, Kings and Tulare Counties-----	1.00
59—Raisin City, Helm and Riverdale, including Wheatville area, Fresno County-----	1.25

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY

State Mineralogist

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No. 3

CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY



QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XLI

DIVISION OF MINES

EXECUTIVE AND TECHNICAL STAFF

WALTER W. BRADLEY

State Mineralogist

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C. A. LOGAN, District Mining Engineer	Sacramento
CHAS. V. AVERILL, District Mining Engineer	San Francisco
J. C. O'BRIEN, District Mining Engineer	Redding
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GEORGE L. GARY, Mineral Technologist	San Francisco
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MARY H. HELM, Geological Draftsman	San Francisco
W. B. WINSTON, Laboratory Aide	San Francisco

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ECONOMIC MINERALS

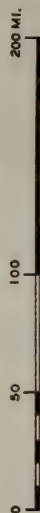
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CALIFORNIA

AND THE

DISTRICTS OF THE DIVISION OF MINES

SCALE



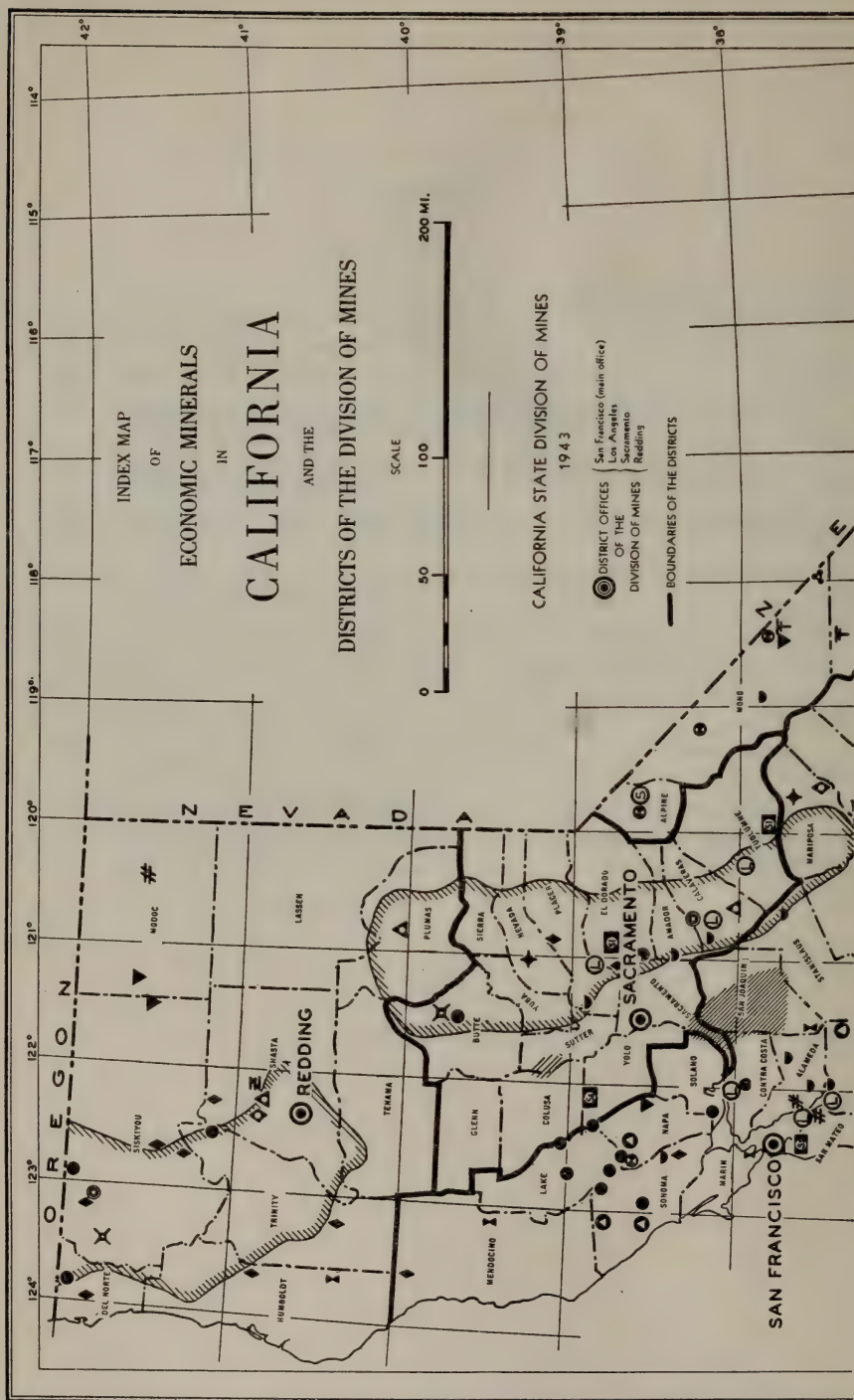
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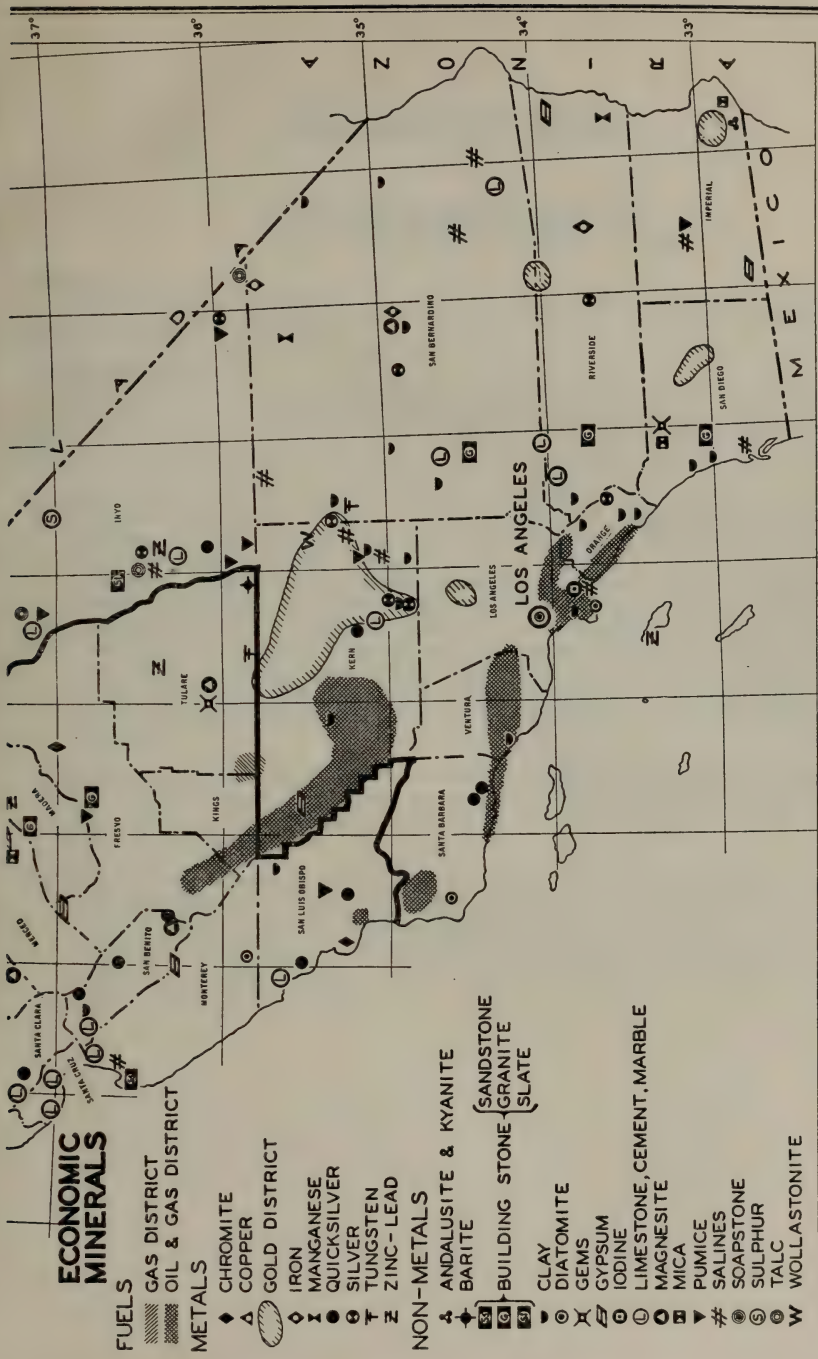
1943

- DISTRICT OFFICES**
OF THE
DIVISION OF MINES

San Francisco (main office)
Los Angeles
Sacramento
Redding

BOUNDARIES OF THE DISTRICTS





ECONOMIC MINERALS

FUELS

- GAS DISTRICT
- OIL & GAS DISTRICT

METALS

- CHROMITE
- COPPER
- GOLD DISTRICT
- IRON
- MANGANESE
- QUICKSILVER
- SILVER
- TUNGSTEN
- ZINC-LEAD

NON-METALS

- ANDALUSITE & KYANITE
- BARITE
- SANDSTONE
- GRANITE
- SLATE
- BUILDING STONE
- CLAY
- DIATOMITE
- GEMS
- GYPSUM
- IODINE
- LIMESTONE, CEMENT, MARBLE
- MAGNESITE
- MICA
- PUMICE
- SALINES
- SOAPSTONE
- SULPHUR
- TALC
- WOLLASTONITE

ADMINISTRATION

ADMINISTRATIVE REPORT

By WALTER W. BRADLEY, STATE MINERALOGIST

Personnel

There have been no changes in personnel to be noted during the past three months.

New Publications

Since last noted, the following publications of the Division of Mines have been received from the State Printer, and are now available at the offices of the Division :

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

October 1944, being Chapter 4 of State Mineralogist's Report XL. This chapter contains: *Administrative Report*; *Biennial Report of the State Mineralogist*; *Current Notes*, Geological Branch; *Pellet Phosphorite from Carmel Valley, Monterey County*; *Geology of the Quartz-Crystal Mines Near Mokelumne Hill, Calaveras County*. Also the following special articles: *Strategic Mica*; *Additional Note on Strategic Mica*; *Marketing Vermiculite*; *An Act (Federal) Providing for the Suspension of Certain Requirements Relating to Work on Tunnel Sites*; *An Act (California) Regulating Mineral, Oil and Gas Brokers and Salesmen*. Also *Total Recorded Value of Mineral Production in California*; *Accessions to the Exhibit*; *Library Report*. The INDEX for Vol. XL, 1944, is also included.

BULLETIN 128, *California Mineral Production and Directory of Mineral Producers for 1943*, by Henry H. Symons, statistician, 222 pages, 10 illustrations. This is the complete, detailed report by substances and counties of the mineral production for the year 1943.

BULLETIN 130, *Economic Mineral Resources and Production of California, A Survey with Reference to Postwar Employment*, by Samuel H. Dolbear, consulting mining engineer, and contributing authors. It is a report to the State Reconstruction and Reemployment Commission under the authority of Chap. 35, Stats. 1944, Fourth Extra Session, which appropriated \$20,000 for the purpose. 460 pages, 19 charts and maps.

GEOLOGIC BRANCH

CURRENT NOTES

By OLAF P. JENKINS *

Expansion of geologic work

Through a special item in the budget of the Division of Mines a fund of \$100,000 has been appropriated by the State Legislature for cooperative work between the Division and the Geological Survey, U. S. Department of the Interior. This means that a total of \$200,000 will be spent during the biennium for geological field investigations of economic mineral deposits in California, with a view of helping to develop the State's mineral industry.

Expansion of topographic mapping

Implemented by Senate Bill 803, which is an act to provide for basic topographic mapping of the State of California, the program of making topographic quadrangles will be greatly expanded. This work, which is done largely by the U. S. Geological Survey under the advice of the State Engineer, Mr. Edward Hyatt, will be coordinated with the needs of the State, Federal, and private agencies. It will be the basis for geologic mapping and will thus be integrated with the cooperative program of the Division of Mines with the Federal Geological Survey.

This topographic mapping program is largely the result of the activities of the State Aerial Mapping Project Committee, whose report and recommendations were submitted to the State Reconstruction and Reemployment Commission in March, 1945.

An index of all topographic quadrangles published in California is now being prepared by the Geologic Branch of the Division of Mines.

* Chief Geologist, Division of Mines.

LOS ANGELES FIELD DISTRICT

MINERAL RESOURCES OF RIVERSIDE COUNTY

By W. B. TUCKER * and R. J. SAMPSON **

OUTLINE OF REPORT

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INTRODUCTION

Riverside County comprises a wide strip of territory stretching across the desert region of the southeastern part of the State from the Colorado River westward to the Pacific slope. In the county are the San Bernardino Mountains, which separate the Mojave and Colorado Deserts; the county thus includes portions of both of these arid wastes. The principal summits of the San Bernardino mountains are San Bernardino and San Gorgonio, measuring, respectively, 10,630 and 11,485 feet in altitude. South of Beaumont are the San Jacinto Mountains, which trend southeast, of which the principal peaks are San Jacinto and Tahquitz, measuring, respectively, 10,805 and 8825 feet in altitude.

The western portion of the county has become, with irrigation, one of the chief garden spots of southern California. Riverside is the fourth largest county in the State, has an area of 7240 square miles and has a

* District Mining Engineer, Los Angeles Field District, California Division of Mines.

** Assistant District Mining Engineer, Los Angeles Field District, California Division of Mines.

Manuscript submitted for publication May 18, 1945.

great variety of agricultural and mineral resources. Since 1929, when the last report on Riverside County was issued by the Division of Mines ¹, the outstanding development affecting the county has been the construction of the Metropolitan Aqueduct to supply water to Los Angeles and cities of the Metropolitan Water District of southern California. The construction of the aqueduct was started in December 1932 and completed in January 1940. The Parker Dam, located north of Parker on the Colorado River, was built to impound the waters of the Colorado River. The intake pump lift above the dam is on the Colorado River in San Bernardino County. The aqueduct crosses the San Bernardino-Riverside County line west of Rice, traversing Riverside County to Cajalco Reservoir, in the extreme western part of the county. From Cajalco Reservoir, the water is distributed to the various cities of the Metropolitan Water District.

The aqueduct has a length of 392 miles, with a capacity of 1500 second feet, or approximately one billion gallons per day. Parker Dam Reservoir covers 717,000 acre feet. There are 38 tunnels, totaling 108 miles; concrete-lined canals, 63 miles; concrete-covered conduits, 55 miles; inverted siphons, 29 miles; distributing mains, 153 miles; Cajalco Reservoir, 100,000 acre feet and 5 other reservoirs totaling 150,000 acre feet; 5 pumping plants to lift water, total height of 1617 feet. The construction of the aqueduct resulted in the building of paved roads to the different construction camps in Coxcomb, Eagle, and Cottonwood Mountains, providing good access roads to mineral deposits in these mountain areas that previously were inaccessible. These roads are especially of importance to the iron deposits in Eagle Mountains, located near the east portal of Eagle Mountain tunnel, the road being from Highway 60 near Desert Center to Eagle Mountain Reservoir and pump lift, 10 miles northwest of Desert Center.

TRANSPORTATION

The southern route of the Southern Pacific Railroad crosses the central part of the county from Los Angeles to Yuma, Arizona. Atchison, Topeka & Santa Fe Railroad furnishes rail transportation both in the western end of the county and also the eastern end of the county from Rice to Blythe. Two national highways traverse the county from west to east—U. S. Highways 60 and 70, from Los Angeles to Riverside or Redlands. One branch near Desert Center runs to Parker, Arizona; the other to Blythe. From Indio, U. S. Highway 99 crosses the county in a southeasterly direction, connecting Indio with El Centro in Imperial County. State Highway 71 traverses the western section of the county from Riverside to Temecula and is known as the inland route to the city of San Diego.

In addition to the above-mentioned highways, there are many excellent State and county roads, all paved, that greatly facilitate transportation, thus aiding in the development of the natural resources of the county.

MINERAL RESOURCES

The mineral resources of Riverside County include metals, structural and industrial minerals, and salines, some of the more important being antimony, asbestos, clay, copper, feldspar, gems, gold, granite,

¹Tucker, W. B., and Sampson, R. J., Riverside County: California Div. Mines Rept. 25, pp. 468-526, 1929.

Year	Gold, value	Silver, value	Coal		Salt		Magnesite		Brick		Pottery clay		Lime and limestone		Miscellaneous stone, ¹ value	Mineral water		Miscellaneous and unapportioned		
			Tons	Value	Tons	Value	Tons	Value	M.	Value	Tons	Value	Barrels	Value		Gallons	Value	Amount	Value	Substance
1891																		125,289 lbs	\$27,664	Tin
1892																		126,000 lbs	32,400	Tin
1893	\$42,412																			
1894	93,322		7,891	\$10,142	1,951	\$3,902												60 tons	100	Gypsum
1895	285,106	\$2,550	7,950	15,000	4,000	8,000					3,700	\$4,230	24,000	\$19,200	\$24,000			18 tons	144	
1896	262,600	13,450	4,952	9,904	4,317	8,634					7,700	9,400	10,000	10,000	27,555					
1897	147,227	4,000	6,282	12,564	4,840	9,680					22,019	22,750	15,000	15,000	17,000			8 tons	160	Mineral paint
1898	189,185	1,384	6,200	12,400	16,000	10,000					11,700	11,250	10,000	10,000	8,000			10 tons	200	Asbestos
1899	163,010	2,000	7,005	19,762	3,600	7,200					4,750	39,500	14,900	16,800	13,470	8,000		300 tons	3,000	Glass sand
1900	140,202	6,848	6,000	15,000	4,000	8,000					1,007	25,542	24,560	18,059				1,000 tons	1,500	Asbestos
1901	109,747	2,150	2,500	7,000	4,000	12,000					3,201	89,787	30,489	16,624	18,000	53,400		50 tons	200	Glass sand
1902	47,947	94	1,200	3,000	20,000	20,000					4,153	114,165	34,320	38,920	20,000	92,998		110 tons	4,400	Asbestos
1903	13,453	130			10,000	20,000					3,817	164,020	53,857	65,332	10,000	8,500		500 tons	500	Glass sand
1904	7,455	80			15,000	15,000					4,712	71,380	41,966	49,232	25,000	21,250		300 tons	3,000	Gypsum
1905	35,690	346									2,838	69,195	40,720	67,970	20,000	20,000		100 tons	1,500	Gypsum
1906	4,432	251									4,607	92,140	60,123	57,712	14,000	20,000		100 tons	1,500	Gypsum
1907	3,356	26					75	\$1,750	3,500	102,000	87,260	174,713	6,000	6,500	571,052			3,000 cu ft	9,000	Marble
1908	5,884	112					2,000	4,000	4,803	74,058	71,231	89,752	8,000	8,000	448,478			3,200 lbs.	170	Bismuth
1909	150	24					324	3,888	22,037	265,550	88,025	97,071	3,000	3,000	121,827	30,000	\$3,000	502 lbs.	100	Marble
1910	5,545	28																10 tons	100	Copper
1911	20,623	2,121																22,665 lbs	2,810	Asbestos
1912	20,202	254																400 tons	2,000	Gypsum
1913	12,601	104																8,000 lbs.	1,016	Copper
1914	10,000	100																3 tons	300	Asbestos
1915	10,789	1,522																400 tons	2,000	Gypsum
1916	7,855	338																8,000 lbs.	1,016	Copper
1917																		400 tons	2,000	Gypsum
1918																		400 tons	2,000	Gypsum
1919																		400 tons	2,000	Gypsum
1920																		400 tons	2,000	Gypsum
1921																		400 tons	2,000	Gypsum
1922																		400 tons	2,000	Gypsum
1923																		400 tons	2,000	Gypsum
1924																		400 tons	2,000	Gypsum
1925																		400 tons	2,000	Gypsum
1926																		400 tons	2,000	Gypsum
1927																		400 tons	2,000	Gypsum
1928																		400 tons	2,000	Gypsum
1929																		400 tons	2,000	Gypsum
1930																		400 tons	2,000	Gypsum
1931																		400 tons	2,000	Gypsum
1932																		400 tons	2,000	Gypsum
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1938																		400 tons	2,000	Gypsum
1939																		400 tons	2,000	Gypsum
1940																		400 tons	2,000	Gypsum
1941																		400 tons	2,000	Gypsum
1942																		400 tons	2,000	Gypsum
1943																		400 tons	2,000	Gypsum
1944																		400 tons	2,000	Gypsum
Totals	\$2,616,188	\$122,855	51,210	\$116,573	76,718	\$122,476	4,921	\$31,570	\$7,512,748	3,322,633	\$5,715,105			\$425,097	\$18,920,325	\$107,005		\$99,268,352		

Grand total value, \$134,976,645

* Riverside County was created March 11, 1893, from portions of San Bernardino and San Diego Counties.

¹ Included granite crushed rock, gravel and paving blocks

² Included part of Los Angeles County

³ Tons of limestone

⁴ See under "Unapportioned"

4-379-11 (11) between pages 122-123

gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, salt, silica, soapstone and tin. Riverside ranked fourteenth among the counties of California in total value of mineral output for 1944. Thirteen different mineral substances were produced commercially in 1944, with a total value of \$5,203,973. The principal minerals produced in order of their importance were: cement, clay, granite, gypsum, limestone, mineral water, silica sand, and stone (miscellaneous).

The Alberhill and Corona clay deposits make up one of three important clay-producing districts in the State, and supply the major portion of the clays required by the clay manufacturers of Los Angeles. The clays produced in the Alberhill-Corona district comprise more than 30 different ceramic types but may be broadly classified into fire clays, refractory bond clays, and red-burning clays, according to their commercial use. The value of gold and silver production in 1941 amounted to \$82,470, which was from mines operating in the Chuckawalla,* Dale, Pinto Basin and Pinacate mining districts. The gold closing order L-208, issued by the War Production Board in October 1942, caused gold and silver production to decline to \$12,309; and caused the suspension of gold mining in the county during 1943 and 1944.

METALLIC MINERALS

Antimony

Mountain Group (Crowell, Mabey Canyon). This group of 4 claims is located in Mabey Canyon, in the Cleveland National Forest Reserve, in sec. 8, T. 4 S., R. 7 W., S. B., $4\frac{1}{2}$ miles southwest of Corona; elevation 1700 to 1875 feet. Owner is J. Erenrecht, Corona, California; under lease and option to R. A. Matthey, Los Angeles.

Antimony in the form of oxides and the sulphide, stibnite (Sb_2S_3), occurs over an area about 200 feet in width and 500 feet in length on the ridge southeast of Mabey Canyon. A series of roughly parallel veins occurs in crystalline rock. The general strike of these narrow veins is northeast, dip 20° SE.; widths 6 inches to 2 feet. In places on slope of hill above the canyon, large boulders of stibnite are found in the overburden. Several veins of antimony are exposed in open cut 50 feet in length, 100 feet in elevation above the canyon. Sorted ore from the open cut which was shipped to Harshaw Chemical Company at El Segundo, assayed 38.7 percent antimony, arsenic 0.34 percent. The shipment amounted to 307 pounds.

Development consists of open cuts and short tunnels. Two men are employed on development work.

Bibl.: State Mineralogist's Reports XIII, p. 31; XV, p. 524; XXXIX, pp. 65-66.

Arsenic

Arsenic in the form of arsenopyrite occurs in the San Jacinto Mountains and is also found in the Elsinore district.

Shining Star group consists of 3 claims situated in sec. 6, T. 6 S., R. 4 W., S.B., in the northwest corner of the town of Elsinore. Owner is James French, Elsinore, California.

The country rock consists of slates and schists with intrusive dikes of felsites and felsitic porphyries. The strike of the veins is N. 25° W.,

* On topographic maps of the U. S. Geological Survey, spelling of this name is *Chuckwalla*. Local usage is *Chuckawalla*.

dip 80° W. The veins have an average width of 2 feet. Sample cut across 2 feet is reported to assay 12 percent arsenic, 7 percent sulphur, 18 percent iron and \$4.80 in gold per ton.

Development consists of two vertical shafts, one of which is 20 feet deep, the other 30 feet deep; also, a crosscut tunnel 75 feet in length. Idle.

Bibl.: State Mineralogist's Report XXV, pp. 468-469.

Copper

This metal is rather widely distributed in Riverside County but the principal deposits are situated in the eastern part in the Eagle, McCoy, Maria, and Palen Mountains.

Anderson Group of Claims. This group comprises 4 claims located in the Pinto Mountains, in T. 2 S., R. 12 E., S.B., 30 miles northeast of Indio; elevation 2200 feet. Owners are Anderson and associates, Indio, California.

The country rock is granite and schist. The veins strike northwestward, and vary in width from 2 to 6 feet. The vein quartz is mineralized with malachite and azurite. Development consists of shaft 80 feet in depth and a tunnel 100 feet in length. Idle.

Bibl.: State Mineralogist's Reports XV, p. 525; XXV, p. 469.

Badger State Group: see Eagle Nest mine.

Big Horn Group. This group comprises 13 claims located in Little Maria Mountains, in T. 3 S., R. 20 E., S.B., 8 miles northwest of Inca Siding on the Santa Fe Railroad; elevation 1200 feet.

A belt of porphyritic rocks, about 300 feet wide, cuts schists and granite; strike $N. 55^{\circ} E.$, dip $30^{\circ} NW$. There are mineralized zones in this belt of porphyry, varying in width from 1 to 6 feet. The vein quartz is copper-stained and shows chrysocolla, malachite, and some bornite.

Development consists of four shafts from 25 to 50 feet in depth. The ore developed is reported to carry from 0.5 to 2 percent copper. Idle.

Bibl.: State Mineralogist's Report XXV, pp. 469-470.

Eagle Nest Copper Mine (Badger-State, Crescent). This mine comprises 9 claims located as Eagle Nest Nos. 1 to 9, inclusive, situated on the east slope of the McCoy Mountains, in Ironwood mining district, secs. 29 and 30, T. 4 S., R. 20 E., S.B., 30 miles by road northwest of Blythe and 7 miles southwest of Inca Siding, on the Santa Fe Railroad; elevation 1000 to 1500 feet. Owners are Larry Coke, Yermo, California, and C. R. Combs, Los Angeles.

The claims were formerly known as Badger-State and Crescent group of mines. From 1907 to 1909 they were operated by E. E. Schellenger and associates of Blythe, California, during which period five shipments of selected ore were sent to Consolidated Kansas City Smelting & Refining Company, El Paso, Texas. The total amounted to 65 tons, assaying gold 0.40 ounces per ton, silver 8 ounces per ton, copper 23.42 percent. From 1915 to 1917, the property was operated by Ironwood Mining Company, Harwood Robbins, president, Riverside, California. In November 1916, this company shipped six tons of selected ore with a net value of \$107.16 per ton. Total production has been

\$7000. The property was relocated by present owners in September 1939.

The formation is schist and granite. The vein occurs along a shear zone in the granite. This zone is from 20 to 30 feet in width with schist between granite walls. The shear zone strikes N. 70° W., dips 35° N., and can be traced on the surface along its outcrop for a distance of 12,000 feet. The mineralization occurs in a series of cross fractures within the shear zone which strikes N. 20° E. These fractures have been filled with quartz-calcite veins, mineralized with copper oxides, azurite, malachite, and cuprite, carrying gold and silver. The ores have from 1 to 25 percent copper and values of from \$4 to \$10 per ton in gold and silver. The quartz-calcite veins vary in width from a few inches to 3 feet, average width being about 18 inches. Between the veins are 4 to 6 feet of barren schist. Former operators sank a series of shallow shafts on the individual veins, then sorted the ore carefully up to 23 percent copper and packed it off the mountain to lower camp, a distance of one mile, then hauled it by wagons to Inca Siding for shipment to smelter.

The principal development has been confined to Eagle Nest No. 7 claim on the west end of the property. A tunnel driven east 200 feet, at 75 feet from portal cut a series of parallel quartz-calcite veins 6 to 12 inches in width. The veins strike N. 20° E. and dip 70° E. to vertical. About 100 feet east of portal, an incline shaft has been sunk on one of these veins to a depth of 40 feet and connecting from the surface with the tunnel level. Approximately 9750 feet east of the west workings are the east workings on Eagle Nest No. 8 and No. 1 claims. A shaft inclined 35° was sunk to a depth of 165 feet, on a vein trending N. 20° E. One hundred feet below the collar of the shaft, a drift was driven west 95 feet along the shear zone. A series of parallel quartz-calcite veins with a N. 20° E. strike and vertical dip were cut in the west drift for a distance of 75 feet from the shaft. Width of veins ranges from 12 inches to 2 feet. Twenty feet west of the shaft, a raise was run to the surface on a high-grade vein of copper ore which had an average width of 18 inches. One hundred feet west of the shaft, a tunnel was driven west on a shear zone for 185 feet; cutting a series of parallel quartz-calcite veins 100 feet west of the portal. These veins range in width from 6 to 12 inches, and are mineralized with copper carbonates. The individual veins carry high values in copper but are too narrow to be of commercial importance. Practically all ore that has been shipped from the property has been from the east workings. Idle.

Bibl.: State Mineralogist's Reports XV, p. 526; XXV, p. 470.

Electric Copper and Gold Mine. This mine comprises one patented claim located in Bundy Canyon, in sec. 25, T. 6 S., R. 4 W., S. B., 5 miles southeast of Elsinore; elevation 1500 feet. Owner is Mrs. Charles Carter, Elsinore, California.

The vein, which strikes N. 10° W. and dips 65° E., is at the contact of schist and granite. The principal mineralization occurs in the schist, over a width of 6 feet. The minerals are cuprite, chrysocolla, chalcopyrite, pyrite, and gold and silver.

Development consists of an incline shaft sunk on the vein to a depth of 60 feet. On 60-foot level a crosscut has been driven east 20 feet and there are drifts north and south on the vein from the crosscut. Idle.

Bibl.: State Mineralogist's Report XXV, p. 470.

Fluor Spar group of 5 claims is in sec. 4, T. 3 S., R. 18 E., S. B., on the southwest slope, at the north end, of Palen Mountains, one mile southwest of Packard's Well. Owners are Louis Favret and L. H. Raines of Blythe, California, and N. A. Anderson of Pasadena, California.

The country rock is monzonite. The vein, which strikes N. 65° E. and dips 45° N., is accompanied by a porphyritic dike on its footwall. As exposed, the vein reaches a width of 5 feet. The vein matter contains malachite and azurite as well as fluorspar, which occurs in bunches and as a dissemination in the gangue, intimately associated with the copper minerals.

The deposit has been exposed by an open cut near the top of a ridge. This cut is approximately 100 feet long, 5 feet wide, and 5 feet deep. Down the ridge to the east there are two shorter cuts in a distance of about 400 feet which expose similar conditions. The owners intend to do additional work on the cut near the top of the ridge.

Bibl.: State Mineralogist's Report XXV, p. 471.

Lion's Den copper claim is in secs. 17 and 18, T. 4 S., R. 22 E., S. B., on the west slope of Maria Mountains about 4 miles east of Cox Siding on the Santa Fe Railroad branch line from Rice to Blythe. Owners are Louis Favret and L. H. Raines of Blythe, California, and N. A. Anderson of Pasadena, California.

The deposit occurs at the contact of a diorite dike and dolomitic limestone. The contact strikes N. 20° E., dips 45° NW. The diorite is on the footwall. The vein at replacement zone as exposed in a cut near the top of the hill, is about 6 feet to 8 feet wide. The copper minerals are malachite and azurite. The cut is about 40 feet long and as much as 10 feet deep. At its north end a 10-foot shaft has been sunk on a cross fracture which strikes northwest. At this point the copper mineralization is more intense, although average values were not determined. About 90 feet down the slope a crosscut tunnel has been driven west about 200 feet, apparently without reaching the contact.

Idle, except for assessment work.

Nancy Copper Mine. This mine comprises 4 claims located 1½ miles west of Iron Chief mine, in Eagle Mountains, sec. 28?, T. 3 S., R. 13 E., S. B., 17 miles east of Cottonwood Springs and 40 miles northeast of Mecca, a station on Southern Pacific Railroad; elevation 3500 feet.

The country rock is quartz monzonite which is cut by a series of parallel diorite dikes. The ore occurs on the contact of quartz-monzonite and diorite. The vein strikes northward and dips 70° W.; its width is 4 feet. The vein is mineralized with malachite, azurite and chalcopyrite. Ore mined is said to carry 4 to 7 percent and \$8. per ton in gold and silver.

Bibl.: State Mineralogist's Report XXV, p. 471.

St. John mine comprises 2 claims located 1½ miles south of Eagle Nest copper mine in the McCoy Mountains, in sec. 32?, T. 4 S., R. 20 E., S. B., 8 miles southwest of Inca Siding, on the Santa Fe Railroad, and 31 miles by road northwest of Blythe; elevation 1500 feet. Owner is R. L. Kennedy, Los Angeles.

The vein, which is 4 to 6 feet wide, is in schist and strikes northwest. Development consists of an incline shaft sunk on the vein to a depth of 75 feet. Idle.

Gold

Although gold is widely distributed in Riverside County, comparatively few deposits of notable commercial value have been discovered to date. The total recorded value of production from 1893 through 1943 was \$2,615,188, being in part a by-product from copper and lead ores. The greater part of this was mined from 1893 to 1901. Prior to 1893, notably from 1876 to about 1886, there was much activity and considerable production which was not officially recorded. This may have exceeded the figures given above. One property, the Good Hope mine, south of Perris, is unofficially credited with a production of about \$2,000,000. Other properties in the same general area with substantial production were the Gavilan mine and the Santa Rosa mine. In the desert area which lies between the San Bernardino Mountains and the Colorado River, probably the greater production has come from properties on the south slope of the Pinto Range.

Alice Mine. This mine is situated in the Pinacate mining district, in sec. 12, T. 6 S., R. 3 W., S. B., 4 miles south of Menifee; elevation 1500 feet. Owner is J. S. Egan Estate, Perris, California. Idle.

Bibl.: State Mineralogist's Reports XII, p. 221; XIII, p. 310; XV, p. 534.

Alice Mine. This property comprises 12 patented claims, situated in the Bendigo mining district, on the west slope of the Riverside Mountains, in secs. 25 and 36, T. 1 S., R. 23 E., S. B., 6 miles south of Vidal; elevation 1600 feet. Owner is Miss Clara Blandix, Hollywood, California.

The property was formerly owned and operated by the Reliance Consolidated Mining Company, E. P. Warner, president, and P. N. Warner, secretary, Banco-America Building, Los Angeles. This company operated from 1933 to 1939.

In 1935 a 50-ton electric amalgamation and cyanide plant was installed at Vidal for treatment of the ore; however, the process was not a success and operations were suspended in the early part of 1939. In February 1942 the property was under lease and bond to Frederic Frei, Los Angeles, who installed a 50-ton concentration and flotation plant and operated the mine until October 1942, when operations were suspended due to gold closing order L-208.

A series of parallel quartz veins occur in gneissoid granite and schist. The principal development is on the Alice vein which strikes northwest, dips 60° NE., and has a width of 2 to 4 feet. The vein quartz is mineralized with free gold, chalcopyrite, malachite, and azurite. The ore mined is reported to carry 0.40 ounces in gold per ton and 1 to 3 percent copper. The estimated tonnage of ore developed in the mine is reported to be 20,000, with an average value of 0.40 ounces in gold per ton and from 1 to 2 percent copper. Ore on dump is reported to contain 3000 tons carrying .25 to .30 ounces in gold per ton. Shipments of siliceous ore made to American Smelting & Refining Company's smelter at Hayden, Arizona, are reported to have averaged \$50 per ton in gold and copper.

The lower tunnel is driven southeast 490 feet on the vein. Upper tunnel has been driven southeast 250 feet on the vein. These workings are connected by a raise on the vein a distance of 125 feet. From the lower tunnel, there is a winze 225 feet in depth. The ore shoot

developed on the lower tunnel level was 125 feet in length, with an average width of 30 inches. Ore has been stoped from lower tunnel level to upper tunnel level for a length of 60 feet.

Mine equipment consists of Ingersoll-Rand compressor, with a capacity of 310 cubic feet. The mill at Vidal has a capacity of 50 tons per day, and is driven by 50 horsepower Fairbanks-Morse diesel engine. Idle.

Bibl.: State Mineralogist's Reports XV, p. 544; XXV, p. 472.

American Flag mine comprises 6 claims situated in the Hodges mining district on the east slope of Mule Mountains, in secs. 30 and 31, T. 7 S., R. 21 E., S. B., 8 miles west of Ripley and 14 miles southwest of Blythe. Owners are E. Norman Rice and G. Henessay, Blythe, California.

A 2- to 4-foot vein of quartz in granodiorite strikes east, and dips 50° N. The vein quartz is mineralized with gold, chalcopyrite, pyrite, azurite, and malachite. Development work consists of a shaft 188 feet in depth sunk on the vein, with drifts west on the 50-foot and 100-foot levels. Ore was milled in Gibson mill with a capacity of 10 tons, with amalgamation and cyanidation. Idle.

Bibl.: State Mineralogist's Report XV, p. 541.

Anaheim mine comprises 4 claims in the Washington mining district, in sec. 5, T. 2 S., R. 10 E., S. B. Owner is Edward Harman, Garden Grove, California. Idle.

Bibl.: State Mineralogist's Report XXV, p. 472.

Atlanta Mines: see North Star.

Bankers Group of Mines. This group of claims is situated in the Chuckawalla Mountains, in sec. 27, T. 6 S., R. 15 E., S. B., 4 miles west of Corn Springs and 7 miles south of Desert Center. Idle.

Bibl.: State Mineralogist's Reports XV, p. 50; XXV, p. 473.

Black Eagle Mines: see under lead-silver.

Black Warrior Mine. This mine comprises 2 claims in the Pinto Mountains, Gold Park mining district, in sec. 16, T. 2 S., R. 9 E., S. B., 12 miles south of Twenty-nine Palms; elevation 3550 feet. Owner is W. F. Keys, Twenty-nine Palms, California. Idle.

Bibl.: State Mineralogist's Reports XVII, p. 354; XXV, p. 476.

Brown Mine. This mine comprises 6 claims situated on the east slope of Arica Mountains, adjoining the Lum-Gray mine on the southeast, in sec. 7, T. 2 S., R. 20 E., S. B., 6 miles southwest of Rice; elevation 1500 feet. Owner is T. H. Mulhall, Tecopa, California. The property was formerly worked by Floyd Brown of Blythe in 1927-1928; relocated as Hillside group of claims by the present owner in 1935.

There are two parallel quartz veins on the property. These veins strike N. 20° W., dip 40° W. The formation is schist and granite. The main development work is on the Brown vein, the easterly vein. Two incline shafts have been sunk on this vein to a depth of 100 and 150 feet. The shafts are about half a mile apart. Ore mined was milled in a 3-stamp mill at Brown's well. Idle.

Bibl.: State Mineralogist's Reports XV, p. 542; XXV, pp. 476-477.

Bryan mine comprises 2 patented claims, Bryan and Dottie Wellborne, situated in Corn Springs mining district, in Chuckawalla Mountains, in sec. 30, T. 6 S., R. 16 E., S. B., 8 miles southeast of Desert Center; elevation 1700 feet. Owner is J. M. Huston, Los Angeles.

Two 2- to 4-foot parallel quartz veins occur in granite, striking northward and dipping 60° E. Ore is reported to have milled \$7 per ton in gold. Development consists of crosscut tunnel 400 feet in length and shaft 60 feet in depth. Idle.

Bibl.: State Mineralogist's Reports XV, p. 537; XXV, p. 477.

Chuckawalla and Model Group of Mines. This group comprises 15 claims situated in Chuckawalla Mountains, in secs. 31 and 32, T. 6 S., R. 16 E., S. B., 8 miles south of Desert Center; elevation 2000 feet. Owners are Mrs. A. R. Enloe, Los Angeles, and Leslie Waldrip, Indio, California. The claims are located as Chuckawalla, Upper Valley, Renegade, and Model groups.

A series of parallel quartz veins, striking north and dipping 60° E., occurs in gneissoid granite. These veins range from 4 to 8 feet in width. Vein quartz is mineralized with free gold associated with pyrite, azurite, and malachite. Ore mined is reported to carry \$10 to \$20 per ton in gold. Development consists of a number of shafts 25 to 50 feet in depth and a number of short tunnels driven on different veins. Idle.

Colorado mine (Justice) comprising one patented claim, is in sec. 32, T. 4 S., R. 4 W., about 4 miles southwest of Perris. Owner is Luke J. MacNamee, 431 Pacific Electric Building, Los Angeles.

Here a 4-inch to 12-inch vein occurs in the granite. Its strike is northwest, dip at surface 11° SW. Development consists of 280-foot slope on 11° inclination. At this depth the dip increases to 33°. At the 205-foot level, there is a drift 180 feet long. Along this drift the vein has been stoped to the surface. Average grade of the ore is said to have been 0.3 to 0.4 ounces of gold per ton, with some high grade as much as \$500 per ton.

In 1935, F. Sandoval, 1315 Angeles Avenue, Hollywood, California, operated a Chilean type mill and plates on this property. It had a capacity of 8 to 10 tons per day.

Bibl.: State Mineralogist's Reports XIII, p. 310; XV, p. 531; XXV, p. 483; XXXI, p. 508.

Cottonwood Springs Custom Mill. The plant is situated at Cottonwood Springs, in the Cottonwood Mountains, in sec. 14, T. 5 S., R. 11 E., S. B., 8 miles northeast of Shavers Summit on U. S. Highway 60; elevation 3100 feet. Owner is R. A. Theobald, Los Angeles.

The mill has a capacity of 40 tons per day. Ore to coarse ore bin, capacity 20 tons, then by belt feeder to 9-inch by 8-inch Fulton jaw crusher to 20-ton fine-ore bin. From fine-ore bin to 4-foot by 4½-foot ball mill, in closed circuit with drag classifier, overflow from classifier to amalgamation plates to amalgamation trap. Water from trap pumped by 2-inch centrifugal pump to cone classifier; overflow from cone to feed from ball mill. Product from bottom of cone to Universal concentrator, or to 2-cell Groch flotation machine; tailings from concentrator to settling tank, and water from settling tank returned to ball mill. The mill is driven by 40 horsepower Buick motor. Recovery is reported to be 85 percent of gold values. Idle.

Frank Hill Mine. This mine comprises 5 claims situated in Dale mining district, on the east slope of Pinto Mountains, in sec. 32?, T. 2 S., R. 12 E., S. B., 6 miles south of New Dale and 26 miles southeast of Twenty-nine Palms; elevation 2600 feet. Owner is Frank Hill Mining Company, Frank Hill, president; R. Gfeller, secretary, Twenty-nine Palms, California.

A 4-foot quartz vein in granite strikes north, and dips 40° W. It is developed by an incline shaft sunk on the vein to a depth of 225 feet, with drifts on 50, 100, and 200-foot levels. Idle.

Gold Crown Mine. The property originally comprised 25 claims situated in the Dale mining district, in secs. 15 and 16, T. 2 S., R. 12 E., S. B., 18 miles southeast of Twenty-nine Palms; elevation 2000 feet. Formerly owned and operated by Gold Crown Mining Company, George A. Novell, president and manager, Monrovia, California.

Gold Crown Mining Company operated the property intermittently from 1926 to 1938. A 50-ton cyanide plant was installed on the property in the early part of 1935 and treated ore from Gold Crown and Nightingale mines to 1938, when the mill was moved to Supply and Nightingale mines in the Dale district in San Bernardino County, the orebodies in the Gold Crown mine having been depleted to a depth of 400 feet.

The Gold Crown vein has a trend of N. 20° W. and dips 75° W. It occurs in granite and has an average width of 4 to 8 feet; average value \$12 per ton. At intervals along the outcrop, the vein has been developed by four shafts with depths ranging from 75 to 640 feet in depth. The principal development has been confined to a double-compartment shaft sunk on the vein for a depth of 640 feet, with drifts on levels run at 100-foot intervals. Total underground development was 6000 feet. Several ore shoots, which ranged from 75 to 100 feet in length and had an average width of 6 feet, were developed along the vein. Ore was stoped from the 400-foot level to surface. About 600 feet of drifts were driven on the 600-foot level but no commercial orebodies were developed. About 2000 feet east of the Gold Crown shaft on the San Bernardino claim, a shaft was sunk on a quartz vein to a depth of 220 feet. The vein strikes N. 15° W., dips 80° E., and is 12 to 18 inches wide. Average value was reported to be \$15 per ton in gold. This claim has been relocated by W. C. Hove, San Bernardino, California.

The claims held by Gold Crown Mining Company were abandoned in 1938 and all equipment moved to the Supply mine. Production of the Gold Crown mine is reported to have been \$250,000.

Bibl.: State Mineralogist's Report XXV, pp. 478-479.

Gold Cup group of 5 claims is on the northeast slope of the Oro Copa Mountains, 3 miles south of Blythe highway and 12 miles west of Desert Center, in sec. 23, T. 6 S., R. 13 E., S. B. Owner is E. G. Sweeney, 355 Norton Street, Long Beach, California.

The granitic country rock is traversed by a quartz vein, which strikes N. 65° to 70° W., and dips about 60° SW. This vein, which is traceable on surface for only 50 feet due to overburden, is in places as much as 18 feet wide. Vein filling is massive quartz, with about 3 feet of brecciated quartz on the hanging wall which is stained yellow by iron oxide and is reported to carry \$48 in gold per ton. Immediately against the hanging wall there is a streak 3 to 6 inches wide said to carry \$320

per ton. Some 500 feet west of the only opening on this vein there is a north-trending massive quartz vein from 12 to 15 feet wide.

The only development work consists of an open cut on the east-west vein. Idle.

Gold Dollar group of 20 claims is in secs. 35 and 36, T. 1 S., R. 23 E., S. B., 5 miles south of Vidal, a station on the Santa Fe Railroad. It is in the Riverside Mountains, 2 miles west of the Colorado River. Owner is J. H. Ware, Kingman, Arizona.

Here a calcite-barite-filled vein, ranging in width from 12 inches to 8 feet, occurs between a mica schist hanging wall and a limestone footwall. The vein strikes N. 15° W. and dips 60° E. Minerals in the vein are chrysocolla and free gold. It has been traced on the surface for some 1500 feet.

Development consists of an upper tunnel driven S. 50° E. for 80 feet to the vein then S. 15° E. for 225 feet on the vein. At 80 feet from the crosscut a winze was sunk 60 feet on the vein. This work exposed an ore shoot approximately 100 feet long, varying in width from 2 to 8 feet. Vein is faulted at the southeast end of this shoot. Pilot samples from this shoot indicated that it contains 0.70 ounces gold per ton. Lower tunnel 300 feet below was driven south 500 feet. The first 300 feet was on the vein but the last 200 feet appears to be in the footwall. The vein here averages only about 2 feet in width. The last 30 feet of vein in the tunnel contained chrysocolla, which seems to be the gold indicator. Idle.

Bibl.: State Mineralogist's Reports XV, p. 544; XXV, p. 479.

Goldfields of America Mine. The property comprises 12 claims situated in the Pinto Mountains in the Piñon mining district, in sec. 4, T. 3 S., R. 10 E., S. B., 16 miles south of Twenty-nine Palms; elevation 3000 feet. Owner is Goldfields of America, Ltd., Otto Notterman, president; Frank Notterman, secretary, San Bernardino, California.

A series of parallel quartz veins occur in granite. The main vein is from 2 to 4 feet wide, strikes north, and dips 50° W. Development consists of an incline shaft sunk on this vein to a reported depth of 100 feet. There are a number of other shafts from 50 to 75 feet in depth. Total amount of development consists of 720 feet. Idle.

Gold Shot mine is in secs. 28, 29 and 33, T. 6 S., R. 4 E., S. B., in the San Jacinto Mountains about 35 miles southeast of Hemet; elevation 5000 feet. Owner is Gold Shot Mines, Inc., Carl J. Christensen, president, Garden Grove, California.

On this property there are several limestone pendants in the granitic country rock. A number of quartz stringers from 3 to 4 inches wide traverse the granite, striking eastward and dipping 55° N. On one of these, a tunnel was driven west 70 feet. At the portal of this tunnel there is a shaft said to be 90 feet deep with a drift 100 feet west on the 50-foot level, with a stope 30 feet long by 3 feet wide from the drift to the tunnel level. The workings were inaccessible on account of water. About 1500 feet north on top of a hill another shaft some 40 feet deep was sunk on a roughly parallel stringer, 2 to 4 inches wide.

A small mill had been erected at the portal of the adit. Idle.

Golden Bee Mine. This mine comprises 2 claims situated on the north slope of Hexie Mountains, in the Piñon mining district, in secs. 15 and 16, T. 3 S., R. 10 E., S. B., 22 miles southeast of Twenty-nine Palms; elevation 3500 feet. Owner is Golden Bee Mines, Ltd., E. Auclair, president and manager; Guy Pierson, secretary, San Bernardino, California.

The Golden Bee vein strikes northward and dips 35° E.; its width is 8 to 30 feet. The country rock is gneissoid granite with intrusions of diabase forming the footwall of the vein and andesite the hanging wall. About 100 feet east of the Golden Bee vein is a rhyolite dike 20 to 50 feet in width that strikes northward and dips 50° E. There is a series of parallel east-trending veins that intersects the Golden Bee vein on the west. The principal development work has been confined to the Golden Bee vein. Irregular shoots of high-grade oxidized ore are found in this large vein of quartz. These high-grade shoots trend to the northeast about 40°. Widths vary from 12 inches to 2 feet. The Golden Bee vein is a fault fissure with heavy clay gouge on both walls. Development consists of a tunnel driven south 100 feet on the footwall of the vein, with a number of crosscuts driven east. North of the tunnel, at same elevation, a shaft has been sunk on an inclination of 85° to 70-foot level, then sunk on an inclination of 50° to 180-foot level. On 180-foot level, drift S. 20° E. 20 feet from shaft and then a crosscut is driven 80 feet east to hanging wall of vein. The vein at this point has a width of 30 feet. Ore is stoped from 130-foot level to surface, only the high-grade lenses in the vein being extracted.

Ore shipments made to Burton Bros., Inc., Rosamond, Kern County, California, and the Gold Crown Mining Company's mill at Dale, San Bernardino County, are reported to have been from one to 6 ounces in gold per ton. Total production to date is \$40,000.

Mine equipment consists of 12 horse power gas-driven hoist, Ingersoll-Rand compressor, air drills. Idle.

Bibl.: State Mineralogist's Report XXXVI, pp. 48-49.

Golden Rod mine comprising 2 claims and mill site, is in the Dale mining district, sec. 1, T. 2 S., R. 12 E., S. B., 40 miles north of Mecca. Owner is O. K. Mining Company, Joseph Ingersoll, president; was under lease in 1940 to Pinto Basin Mining Company, C. Carlton, president; Wm. Leshner, secretary, Indio, California.

The vein, in granite, strikes north, dips 80° W.; width 2 to 4 feet. A shaft has been sunk on the vein to 350 feet. Drifts have been driven north and south on the following levels: 40, 80, 130, 200, 250, and 350 feet. On the 200-foot level, drift north 300 feet, south 50 feet; on 250-foot level drift north 65 feet; south 65 feet on 300-foot level, north 75 feet and south 100 feet. Ore shoot is 75 to 100 feet in length with an average width of 4 feet.

Although there was a small mill on the property (10 tons capacity) the ore was hauled to the Gold Crown Company's mill for treatment. Shipments are said to have run from 2 to 4 ounces of gold per ton. Idle.

Bibl.: State Mineralogist's Report XXXVI, pp. 49-50.

Good Hope mine is in sec. 15, T. 5 S., R. 4 W., S. B., 4½ miles southwest of Perris, in the Pinacate mining district. Owner is Velma A. Teater, Los Angeles.



SHAFT AT GOLDEN BEE MINE. RIVERSIDE COUNTY

Piñon mining district, 12 miles southeast of
Twenty-Nine Palms

This is an old property originally worked by Mexicans. As early as 1894 it was equipped with a 20-stamp mill and had been developed to a depth of 485 feet. By 1896 the property was shut down and in litigation. No further work was done with the exception of some desultory mining by leasers and the treatment of tailings by cyanide until 1933 when the property was taken over under purchase contract by Good Hope Development Company, James M. Hyde, president; Clifford H. Marker, secretary, with offices in the Security Building, Los Angeles. This property is credited with a production of \$2,000,000.²

The country rock in the vicinity of the Good Hope mine is granitic. In this granodiorite occur dikes, apparently felsitic phases of the same magma which formed the main mass. There are two sets of north-trending veins on the property. The easterly set, known as the Good Hope, dips 55° W. About half a mile west are the Water vein fractures, which dip steeply to the east. Practically all of the development work has been done on the Good Hope veins. Near the surface there are several veins in the Good Hope system, which, according to old reports, appear to unite in depth, forming an irregular, branching fissure. The branches go into the footwall from the main fracture which contains the Good Hope vein. In places this fracture is poorly defined, in others there is a heavy clay gouge and the quartz is fractured, indicating long-continued movement. The vein is accompanied by one of the felsitic dikes mentioned above. These dikes vary in thickness from a few feet to as much as 30 feet, and at the surface are on the hanging-wall side of the vein; underground they are on the footwall side.

To the north a basic dike of variable thickness, strike N. 20° E., appears to mark the northern limits of the ore. From this point south for a distance of more than 2000 feet, open cuts at various places along the outcrop show that the vein matter carries gold. The stope map published herewith (fig. 1) indicates that the vein has been stoped along an almost continuous length of about 1600 feet. The ore is free-milling near the surface, containing some high-grade pyrite, while below the 250-foot level much of the gold content is in the sulphides. Two veins, the Good Hope and Back, have been worked. The Back vein is approximately 27 feet in the footwall of the Good Hope vein, in the upper levels.

The Good Hope Development Company, the last lessee, unwatered and retimbered the shaft to the 350-foot level. On the 95-foot level a drift was driven south 150 feet on the Back vein. On the 166-foot level a crosscut was driven east 60 feet. For other development, see section of mine printed herewith (fig. 1). A mill was erected on the ground and several thousand tons from the old dumps together with ore from the development were milled. This company planned to get to the bottom level (the 550-foot) where they expected to find ore exposed in the drifts; but about 1936 litigation developed which stopped the operation, and nothing has been done since.

Bibl.: State Mineralogist's Reports VIII, p. 527; IX, p. 151; XI, p. 106; XII, p. 221; XIII, p. 311; XV, pp. 532-533; XXV, p. 480; XXXI, pp. 509-511.

Granite Mine. This mine comprises 6 claims situated on the north slope of the Chuckawalla Mountains, in sec. 35, T. 5 S., R. 15 E., S. B., 3 miles south of Desert Center; elevation 1000 feet. Owner is H. K. Hen-

² Merrill, Frederick J. H., Los Angeles County, Orange County, Riverside County: California Min. Bur. Rept. 15, p. 527, [1917] 1919.

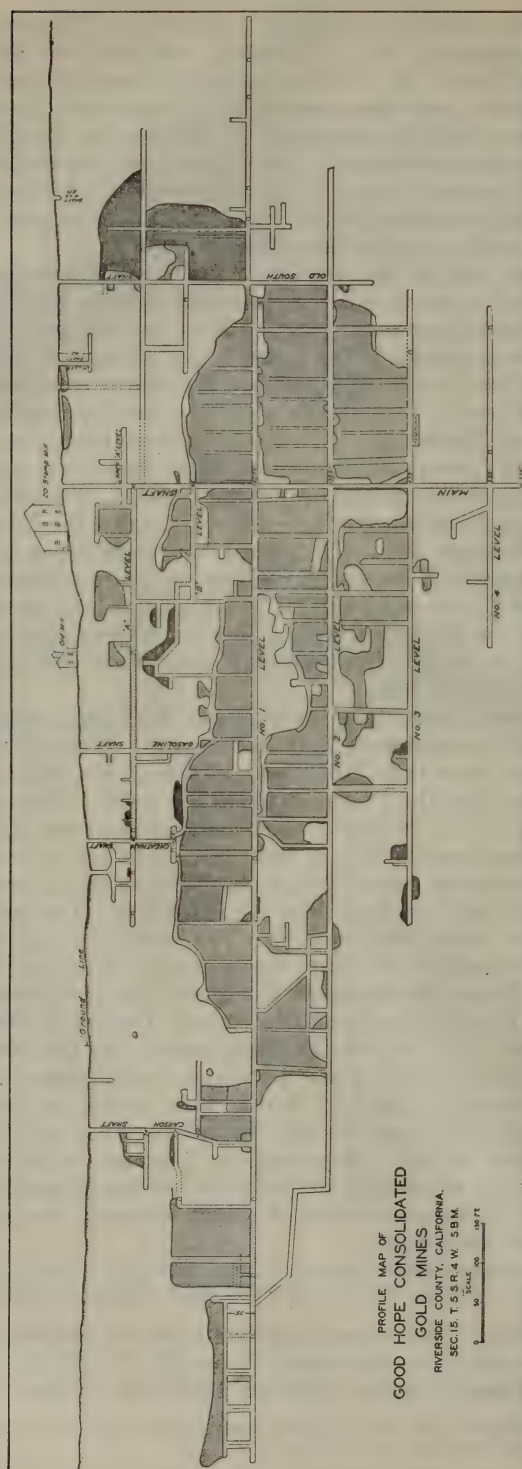


FIG. 1. Profile map of Good Hope Consolidated Gold Mines, Riverside County, California. Reprinted from Division of Mines Report XXXI, p. 510

nigh, Desert Center, California. This property was operated in 1928 and 1929 by Chuckawalla Mining & Milling Company, A. G. Karpe, president, Los Angeles.

The company installed a 20-ton amalgamation and concentration plant on the property and milled a small tonnage of ore reported to average \$8 per ton in gold.

The vein occurs with a fine-grained dike in granite. Strike is N. 10° W., dip 50° W. Development consists of a number of tunnels. The main working tunnel is driven as a crosscut 600 feet west, intersecting the vein at this point, with drift 400 feet north on the vein. There is a raise from this point to the surface on vein. Idle.

Hexahedron Mine. The Hexahedron mine comprises 2 claims situated in the Pinto Mountains, in Pinon mining district, in sec. 10, T. 2 S., R. 10 E., S. B., 16 miles southeast of Twenty-nine Palms. Idle.

Bibl.: State Mineralogist's Reports XII, p. 223; XIII, p. 311; XV, p. 531.

Hoag mine, on Hoag Ranch which comprises 400 acres in secs. 13 and 24, T. 4 S., R. 5 W., is one mile northwest of the Gavilan mine, about 7 miles west of Perris. Owner is H. M. Harford, Perris, California.

The vein, from a few inches to 2½ feet wide, occurs in granite. Its strike is northwest, its dip 40° S. Ore occurs in lenses of limited length on both strike and dip. The mine was worked in 1884-1886, during which time it is reported to have produced \$140,000. Ore was milled in a 5-stamp mill on the San Jacinto River, 14 miles southeast of the mine. The old workings consisted of a 300-foot shaft sunk on the vein, with four short levels. There was also a 150-foot shaft with which an adit connected at 100 feet.

Beginning in 1932, the present owner sank a vertical shaft 78 feet at 100 feet north of the old shaft. He then went down the hill 140 feet and sank a shaft 60 feet vertically and 117 feet on the vein, total depth of shaft being 177 feet. On the 137-foot level drifted 14 feet north and 14 feet south and on the 157-foot level, 70 feet north and 25 feet south. He also put up a raise 50 feet to one of the old levels. While some spotted values were encountered in these workings, the owner believed that the shoot raked too far north to be tapped by them. The mine was full of water at the time of visit.

Bibl.: State Mineralogist's Report XXXI, p. 512.

Ida-Leona Mine (Gavilan). The property comprises 360 acres situated on the Rancho Sobrante de San Jacinto, in the Pinacate mining district, in secs. 19 and 20, T. 4 S., R. 4 W., S. B., 6 miles northwest of Perris; elevation 2200 feet. Owner is Ida-Leona Mining & Milling Company, H. L. Nelson, president and manager, Perris, California.

There are two systems of veins occurring in granite. The most important veins are the Gavilan and Ida-Leona which are roughly parallel, about 400 feet apart. The Gavilan vein strikes N. 65° W., dips 30° S.; its width is 12 inches to 2 feet. It is developed by a shaft sunk on the vein to a depth of 485 feet (workings caved). The Ida-Leona vein strikes N. 65° W. and dips 60 to 65° S.; it is 12 inches to 4 feet wide, and is 400 feet south of Gavilan vein. About 500 feet east of the Ida-Leona shaft is a 2-foot vein which strikes N. 15° W. and dips 40° W. This vein intersects both the Gavilan and Ida-Leona veins. Present development is confined to the Ida-Leona vein. A 2-compartment shaft has been sunk

on the vein to a depth of 350 feet, with drifts east and west of shafts on the following levels: 100, 150, 250 and 300 feet.

On the 100-foot level drift 200 feet east and 200 feet west; on the 150-foot level drift 115 feet east; on the 250-foot level drift 100 feet east, and 100 feet west; on the 300-foot level drift 100 feet east. Ore shoot developed is 75 to 100 feet in length, with an average width of 2 feet. Quartz shows free gold associated with pyrite and galena. Ore mined from stopes is reported to carry from \$25 to \$50 per ton in gold.

Power plant consists of 150-horsepower diesel engine direct-connected with generator; 25-horsepower electric-driven hoist; 300-cubic feet C.P. compressor. Mine run of ore is hoisted in one-ton skip to 135-ton coarse-ore bin. Ore is trammed from coarse-ore bin to small ore pocket to 6-inch by 8-inch jaw crusher, by bucket elevator to fine-ore bin with a capacity of 35 tons; from fine-ore bin by belt feeder to No. 43 Marcy ball mill (3 feet by 4 feet) in closed-circuit-duplex Dorr classifier; ground to 40-mesh. Discharge end of ball mill equipped with Hardinge amalgamator, in which 80 percent of the coarse gold is recovered; overflow from classifier to amalgamation plate 5 feet long by 4 feet wide; then pulp to Diester table. Mill has a capacity of 30 tons per 24 hours. Mill is driven by 75-horsepower Holt gas engine.

Some very high-grade ore mined was shipped to U. S. Smelting Company, Salt Lake City, Utah. Production to date is reported to be \$50,000. Operations were suspended in October 1942, on account of gold closing order L-208.

Bibl.: State Mineralogist's Reports XI, pp. 334-337; XIII, p. 311; XV, p. 528; XXV, p. 478; XX, p. 321; XXXI, pp. 508-509; XXVI, pp. 50-51.

Iron Chief Mine. The property comprises 6 claims situated in Eagle Mountains, in sec. 27, T. 3 S., R. 13 E., S. B., 20 miles northeast of Cottonwood Springs and 28 miles northeast of Shavers Summit, on U. S. Highway 60; elevation 2500 to 3000 feet. Owner is Southern Pacific Land Company, San Francisco, California.

The ore deposit is a replacement which occurs on contact of limestone and quartz diorite. The replacement zone is 6 to 8 feet in width. Along the contact is heavy iron gossan which extended to a depth of 140 feet, where the sulphide zone was encountered. The vein filling was hematite and quartz, reported to average \$10 in gold per ton. The minerals in the sulphide zone are pyrite and chalcopyrite, carrying gold values. The contact vein strikes N. 70° W. and dips 45° N.

Development consists of a vertical shaft 140 feet in depth and a 500-foot crosscut tunnel which intersected the shaft on the 100-foot level. On 100-foot level there was 500 feet of drifting on the vein which was stoped to the surface over a length of 300 feet. The ore was treated in 50-ton cyanide plant. There remains on the property about 8000 tons of tailings. Total production was \$150,000. Idle.

Bibl.: State Mineralogist's Report XXV, p. 482.

Little Maggie, comprising 2 claims, is in the NW $\frac{1}{4}$ sec. 33, T. 4 S., R. 4 W. Owner is Chas. Lanhorn, Box 152, Perris, California.

Vein in granite strikes east, dips 30° S.; width 2 to 8 inches. Main shaft is sunk on the vein to 175 feet. East of this shaft about 80 feet, another shaft has been sunk on the vein to 75 feet. About the same distance west of the main shaft, another 75-foot shaft has been put down. Average value of the ore is reported to be \$32 per ton.

In 1935 a Chilean mill with inside amalgamation and plates was being operated. A gas engine supplied the power; capacity about 10 tons per day. Idle.

Bibl.: State Mineralogist's Reports XII, p. 223; XIII, p. 312; XXV, p. 483; XXXI, p. 512.

Lost Angel Mine. This mine comprises 8 claims situated on the southwest slope of the Little San Bernardino Mountains in sec. 22, T. 3 S., R. 8 E., 16 miles northeast of Indio; elevation 3500 feet. Owner is C. L. Woods, Indio, California.

Quartz vein occurs in granite, strikes northwest; its width is 2 to 4 feet. Development consists of shaft 75 feet deep and a tunnel driven on vein 150 feet. There is a 5-stamp mill on the property. Idle.

Lost Horse Mine. This property comprises one patented claim, situated in the Piñon mining district, in sec. 3, T. 3 S., R. 8 E., S. B., 28 miles northeast of Indio; elevation 5000 feet. Owner is J. C. Ryan Estate, Los Angeles.

The vein occurs in a micaceous quartzite and granite, strikes east, and dips 85° N. Development consists of a tunnel 80 feet in length driven on the vein and a shaft sunk on the vein to a depth of 500 feet. There is a small amount of drifting on the vein on the 100, 200, 300 and 400-foot levels.

In 1936 the property was under lease, and pillars of ore were extracted from the upper levels and milled in a 10-stamp mill. Reported production is \$350,000. Idle.

Bibl.: State Mineralogist's Reports XII, p. 223; XIII, p. 312; XV, p. 536; XXV, p. 483.

Lost Pony Mine (Desert Center). The Lost Pony mine comprises 6 claims situated in the Chuckawalla mining district in the Chuckawalla Mountains, in sec. 33, T. 6 S., R. 15 E., S. B., 6 miles south of Desert Center; elevation 1600 feet. Owner is Dell Barnum, Desert Center, California. In 1940, the property was under lease to Desert Center Mining Company, Jackson C. Hill, president and Harry Bonnell, manager. This company made a number of shipments of high-grade ore to American Smelting & Refining Company's smelter, Garfield, Utah.

A 2- to 4-foot quartz vein in gneissoid granite strikes northwest, dips 50° SW. Development consists of an incline shaft sunk on the vein to a depth of 200 feet with drifts on the vein on the 50, 100 and 200-foot levels; also an incline shaft 50 feet deep.

Mine equipment consists of 6 horse power Fairbanks-Morse gasoline-driven hoist; 110 cubic foot Sullivan compressor; Straub mill and amalgamation plates. Idle.

Lucky Strike (Ophir), comprising 4 claims, is on the east side of the highway, half way between Perris and Elsinore, in sec. 22, T. 5 S., R. 4 W., S. B. Owners are R. S. Fisher and R. L. Reade, Elsinore, California.

The country rock is granitic. Two veins on the property strike east, dip 45° S. and 35° S., intersecting on the dip at the 50-foot level. The more steeply dipping vein carries free gold. The other vein has higher silver values and other metallic minerals are marcasite, pyrite, and arsenopyrite. On the 50-foot level the vein is from 2 to 24 inches wide, averaging about 10 inches. The ore shoot on this level is 25 feet long.

Development consists of 150-foot shaft sunk on an inclination of 45° . On the 150-foot level, drift 150 feet north; on 50-foot level, drift 100 feet north. Lower level was under water at time of visit. Reported to show 30 inches of sulphide ore carrying 25 ounces of silver and \$8 in gold.

Equipment consisted of 9-horse power gasoline hoist. Mill equipment included 6-inch by 8-inch jaw crusher; 3-foot hammer mill in closed circuit with Atkins classifier and a Wilfley table. Power was supplied by a 30-horse power gasoline engine.

Bibl.: State Mineralogist's Reports XIII, p. 313; XV, p. 532 XXV, p. 486; XXXI, p. 513.

Lum Grey (Priest) mine comprising 4 claims is on Arica Mountain in sec. 7, T. 2 S., R. 20 E., S. B., 5 miles south of Rice, a station on the Parker Branch of the Santa Fe Railroad; elevation about 1500 feet. Owner is F. E. Dennewiler, Blythe, California.

The quartz vein in monzonite strikes N. 20° W., dips about 60° SW.; varies in width from one to 10 feet. The ore is oxidized to a depth of 150 feet, below which point it is said to carry considerable pyrite. The ore shoot developed to a depth of 150 feet was approximately 200 feet long, having an average width of about $2\frac{1}{2}$ feet, and is said to have averaged approximately 0.75 ounces in gold.

Property has been developed by a shaft said to be 990 feet deep. This shaft has a bulkhead at approximately 150 feet from the collar. A three-compartment shaft was sunk 175 feet at 300 feet east of the deep shaft. Ore was stoped from 137-foot level to the surface for a length of approximately 200 feet. Assay map of pillars remaining shows ore from one to 10 feet wide carrying good gold values. Idle.

Bibl.: State Mineralogist's Report XV, pp. 541-542; XXV, p. 481.

Mastodon Mine. The Mastodon mine comprises one claim, situated in Cottonwood Springs mining district, on the northeast slope of Cottonwood Mountains, in sec. 23, T. 5 S., R. 11 E., S. B., half a mile east of Cottonwood Springs and 8 miles northwest of Shavers Summit, on U. S. Highway 60; elevation 3200 feet. Owner is George W. Hulsey, Indio, California.

Three parallel quartz veins occur in granite, strike N. 30° W., dip 40° E.; width of veins 8 to 12 inches. Development consists of a shaft sunk on an inclination of 40° to a depth of 45 feet on west vein. Ore milled is reported to average \$40 per ton in gold.

Missing Link (Virginia Shay) mine, comprising 6 claims, is in the NE $\frac{1}{4}$ sec. 32, T. 4. S., R. 4 W., S. B., about 4 miles west of Perris. Last known owner is Hugh Duff, 626 Wesley Roberts Building, Los Angeles. This property was leased to H. L. Musick, 2336 Whittier Boulevard, Los Angeles, in 1930-1931.

There seem to be two veins on this property one of which, according to old reports of the State Mineralogist, strikes N. 50° E., and dips 60° SE. The other strikes N. 75° E., and dips 56° SE. These veins traverse the granitic country rock but in places the hanging wall is a mica schist. They range from a few inches to 3 feet in width.

The N. 50° E. vein was worked in the '80s, for a considerable distance along its strike. While most of this was shallow surface work, a depth of 200 feet was reached in one place. The ore is said to have yielded \$30 per ton. The lessee mentioned above, sank a shaft on the

N. 75° E. vein, some 55 feet west of the old 200-foot shaft. This shaft at the time of last visit was 100 feet deep. At this level, a drift was driven west 117 feet, with a 25-foot crosscut in the hanging wall at the face. The vein in the drift is about 3 feet wide but carries practically no values. A crosscut was being driven in the footwall in an attempt to pick up the ore shoot formerly worked on the other vein. As the operation ceased shortly after this, final results of this work were not learned.

Bibl.: State Mineralogist's Reports VIII, p. 526; XI, p. 385; XII, p. 225; XIII, p. 313; XV, p. 532; XXV, p. 485.

Mission Gold Mines (Huff-Lane) comprising 7 claims and 2 mill sites, known as the Lone Star group, situated in sec. 5, T. 3 S., R. 12 E., S. B., in Pinto Basin mining district, are 42 miles northeast of Mecca; elevation 1200 to 1500 feet. Owner is E. C. Huff, Los Angeles. In 1940 the property was under lease to Mission Gold Mines, Inc., C. H. Henderson, president, San Diego, California, F. J. Foulkes, secretary and T. J. Aike, manager, Mecca, California.

The vein strikes north, and dips 80° E., in granite; its width is 2 to 4 feet. Development consists of a shaft sunk on the vein 600 feet. On the 122-foot level there is a drift 533 feet north and 191 feet south. At 388 feet there is a raise on the vein to the surface, 120 feet. Ore shoot developed was 2 feet wide and 60 feet long. Two hundred sixty tons of ore milled from a stope in this shoot are reported to have had an average value of \$25 per ton in gold. Other development consists of 400-foot level, drift north 100 feet, south 120 feet; 600-foot level, drift north 325 feet and south 100 feet. Ore shoot developed north of the shaft on 600-foot level, is 2 feet wide by 200 feet long. Four shipments of ore from this shoot to the Gold Crown Mining Company's mill are reported to have averaged \$43 per ton in gold.

Mine equipment consists of 6-horsepower gasoline hoist and Gardner-Denver compressor, driven by automobile engine. Idle.

Bibl.: State Mineralogist's Report XXV, pp. 481-482.

Morning Star Mine (Jackknife). This mine comprises 8 claims situated in Bendigo mining district in the Riverside Mountains, adjoining Mountaineer group of mines on the south, in sec. 31, T. 1 S., R. 24 E., and sec. 6, T. 2 S., R. 24 E., 7 miles south of Vidal; elevation 1250 feet. Owner is Morning Star Mining Company, B. H. Stansbury, president, Los Angeles; under lease to D. M. Hunsaker, San Gabriel, California.

Quartz vein on contact of limestone and schist, strikes N. 55° E. and dips 50° NW.; width 2 to 6 feet. Development consists of incline shaft sunk on the vein to a depth of 100 feet. It is reported that in 1918-1919 400 tons of ore shipped from the property carried 14 percent copper and \$21 per ton in gold. Idle.

Mountain Queen Mine. This property comprises one claim located as the Juanita No. 5, and is now one of the claims of Lum Gray mine. It is a quarter of a mile southeast of the Lum-Gray shaft, on the east slope of the Arica Mountains, in sec. 7, T. 2 S., R. 20 E., S. B., 6 miles southwest of Rice, a station on the Santa Fe Railroad; elevation 1500 feet. Owner is Walter Denewiler, Blythe, California.

The vein occurs on contact of limestone and gneissoid granite, the limestone forming the hanging wall, the granite the footwall. The vein

strikes N. 70° W., dip 65° S.; width 2 to 4 feet. Development consists of a tunnel driven northwest 100 feet, then a winze sunk on the vein on an inclination of 40° to 200-foot level. Orebody developed and stoped above tunnel level was 70 feet in length, with an average width of 2 feet. It is reported ore had an average value of \$12 per ton in gold. Idle.

Mountaineer Mine (Calzona Mine). The property comprises 16 claims situated in the Bendigo mining district on the east slope of the Riverside Mountains, in sec. 31, T. 1 S., R. 24 E., and sec. 36, T. 1 S., R. 23 E., S. B., 6 miles southeast of Vidal; elevation 1200 feet. Owner is Mountaineer Mining Company, H. E. Olund, president; B. H. Stansbury, secretary, Los Angeles.

This group of mines was owned and operated by Calzona Mines Company from 1898 to 1920. Production from 1912 to 1916 was 300 tons (at 1.5 ounces, gold at \$35.00), or \$15,750. In 1920, the property was acquired by Mountaineer Mining Company and operated from 1920 to October, 1935. In 1935, the production was 1540 tons (average value \$9.18 per ton) or \$14,140.

The formation is limestone and schist, cut by intrusive diabase dikes. There are two parallel fissures on contact of limestone and schist that strike northwest, dip 60° E. The orebody is a replacement deposit along the contact. The ore is stained with iron and manganese oxides and copper-stained quartz, carrying values in copper, gold, and silver. The orebody developed is from 6 to 15 feet in width. Development consists of a tunnel 200 feet and an incline shaft 200 feet deep sunk on an inclination of 60°. From the shaft, drifts have been driven on the orebody on 100 and 200-foot levels. On 100-foot level drift southeast 100 feet; on 200-foot level drift southeast 235 feet. The ore shoot developed on these levels is from 60 to 100 feet in length, with an average width of 6 feet. The ore mined is reported to carry from \$15 to \$35 in gold, with 2 to 3 percent copper. There is a raise from the 200-foot level driven to intersect winze from the tunnel level.

Equipment consists of 100-horsepower Fairbanks-Morse diesel engine, direct-connected to 75 K.V.A. generator (15-inch by 12-inch) (9-inch by 12-inch) Imperial Type Ingersoll-Rand compressor; single-drum 30 horsepower electric hoist.

In 1935, a 50-ton flotation plant was installed on the property. It was operated for a short time, treating 1460 tons of ore, but operations were suspended due to low recovery made by flotation. About 100 tons of crude ore was shipped to smelter at Salt Lake, Utah, which had an average value of \$35 per ton. Water for operating mine and mill was pumped from Colorado River through 1½-inch pipe line, a distance of 1½-miles. Idle.

Bibl.: State Mineralogist's Reports XV, pp. 542-543; XXV, p. 477.

North Star Group of Mines (Atlanta). The North Star group comprises 5 claims, located as North Star, North Extension, South Extension, Extension No. 4 and No. 5, situated in Gold Park mining district, on the west slope of Pinto Mountains, in sec. 1, T. 2 S., R. 9 E., 6 miles south of Twenty-nine Palms; elevation 3600 feet. Owner is Floyd Mining & Milling Company, Earl F. Skadan, president; G. C. Zimmerman, secretary, Norco, California.

A narrow quartz vein occurs in granite; strike N. 10° E., dip 85° E.; width 12 inches to 2 feet. On North Star claim a 2-compartment shaft was sunk to a depth of 60 feet on the vein. Ore extracted from the shaft is reported to have milled \$25 per ton in gold. On what was formerly known as the Atlanta claim to the south of North Star shaft, there is a shaft 100 feet in depth. At 100 feet in elevation from the collar of this shaft, a tunnel has been driven north 270 feet; at a point 200 feet north of portal, a raise has been put up to intermediate tunnel, a distance of 150 feet. The intermediate tunnel is driven north 170 feet. A narrow vein is exposed in upper tunnel and the ore shoot developed had a length of 15 feet. Some very high-grade ore was mined from this level. Idle.

Bibl.: State Mineralogist's Report XVII, pp. 347-348; XXV, pp. 472-473.

Oro Vista Mine. This mine comprises one claim situated in the Santa Rosa Mountains, in sec. 28, T. 7 S., R. 5 E., S. B., 6 miles southwest of Nightingale Camp, on the Palms to Hemet highway, 18 miles southwest of Indio; elevation 6000 feet. Owners are C. E. Carroll and Chas. Ward, Los Angeles.

A quartz vein occurs on contact of granite and schist; strike is east, dip 70° N. Width is 4 to 6 feet. Development consists of a shaft sunk on vein to a depth of 10 feet and shallow open cut 8 feet in length. Idle.

Paymaster Mine. The Paymaster mine comprises 3 claims situated in Piñon mining district, in the Pinto Mountains, in sec. 15, T. 3 S., R. 10 E., S. B., 18 miles southeast of Twenty-nine Palms; elevation 3000 feet. Owners are P. O. Murphy and E. Leith, Twenty-nine Palms, California.

The vein occurs in schist, strike northwest, dip 40° SW.; width 2 feet. An incline shaft is sunk on the vein to a depth of 140 feet, with drifts on 50 and 100-foot levels. Ore shipped to Burton Bros., Rosamond, Kern County, is reported to have milled \$35 per ton in gold. Idle.

Red Cloud Mine. This mine comprises 3 patented claims known as Great Western, Red Head and White Wings, totaling 60 acres, situated in the Chuckawalla Mountains, in sec. 5, T. 7 S., R. 15 E., S. B., about 9 miles south of Desert Center and 48 miles southeast of Indio; elevation 2000 feet. Owner is J. D. Huston, 237 South Irving Boulevard, Los Angeles.

The property was operated by Red Cloud Mining Company, J. M. Huston, secretary, from 1898 to 1900, during which time the White Wings shaft was sunk on the vein to a depth of 267 feet and the Great Western shaft to a depth of 480 feet. On the Red Head claim, a tunnel was driven north 250 feet. Ore was hauled to a 5-stamp mill at Corn Springs and milled, and is reported to have had an average value of \$12 per ton in gold. The property was idle until November 1931 when it was taken over under lease and bond by Charles V. Craig and associates of Los Angeles, who installed a small amalgamation plant. The ore milled was from the Red Head tunnel level. The heads treated were reported to average \$20 per ton in gold. The concentrates shipped to U. S. Smelting Company, Midvale, Utah, had an average value of \$100 per ton in gold. Operations were suspended in 1933.

In 1934, the S & W Mining Company, B. F. Schmidt, president, secured an option on the property and operated until December 1936. This company sank an incline shaft on the vein on the Red Head claim to a depth of 200 feet. In the development work they encountered a high-grade shoot of oxidized ore on the footwall of the vein. The production by this company was \$30,000 in bullion and concentrates. The concentrates produced are stated to have carried from 20 to 26 ounces in gold per ton.

In January 1937, the property was under lease to Cecil H. Smith, who operated it until June 1937. He shipped 300 tons of ore stated to have averaged 1.43 ounces per ton in gold. In January 1938, the property was under option to Frank Ahlberg and associates of Los Angeles, who operated until September 1939, during which time a 25-ton amalgamation and cyanide plant was installed on the property. The Red Head shaft was sunk to a depth of 300 feet. In October 1939, the mine was under lease to Super Products, Inc., Mark F. Jones, president, Los Angeles, and operated until 1940.

The Red Cloud vein occurs on contact of gneissoid granite and porphyry. The hanging wall is granitic porphyry and the footwall is gneissoid granite. The vein strikes N. 20° W., dips 60° E.; width 6 to 15 feet. The vein quartz is mineralized with free gold, associated with pyrite. Development work consists of three shafts and a number of tunnels. The Great Western shaft is sunk on the vein to a depth of 480 feet, with levels at 100, 150, 210, 250, and 350 feet. White Wings shaft is sunk on the vein to a depth of 267 feet, with levels at 100, 180, and 220 feet. About 500 feet north of White Wings shaft is the Red Head shaft, which has been sunk on the vein to a depth of 310 feet, with levels at 100, 200, 275, and 300 feet. All recent work has been confined to this shaft and the Red Head tunnel which has been driven north on the vein for a distance of 250 feet. In sinking this shaft to the 100-foot level, a sulphide orebody was encountered on the hanging wall of the vein, the vein material being heavily mineralized with cube pyrite. This orebody was 12 feet wide and 50 feet in length and reported to average \$15 per ton in gold. From the 200-foot level to the 300-foot level on the footwall side of the vein, a high-grade lens of oxidized quartz was encountered. The lens of ore was 30 feet in length, 4 feet in width and reported to average \$50 per ton in gold. The ore shoot was cut off by a fault striking east between the Red Head shaft and White Wings shaft. The vein quartz of this orebody showed coarse gold.

Total production of the property is reported to have been over \$100,000. Operations were suspended in 1940 and all equipment has been removed from the property.

Bibl.: State Mineralogist's Reports X, pp. 900-901; XV, p. 539; XXV, pp. 486-487; XXXVI, pp. 51-52.

Roosevelt and Rainbow group of mines (Santa Fe) comprises 8 claims situated in the Hodges mining district, on the east slope of Mule Mountains, in secs. 17 and 18, T. 8 S., R. 21 E., S. B., 8 miles southwest of Ripley and 14 miles southwest of Blythe; elevation 1000 feet. Owners are L. A. Stanchfield, C. H. Woodbury, Los Angeles. John Anderson, Palo Verde, is the owner of Rainbow group.



WHITE WINGS SHAFT, RED CLOUD MINE, RIVERSIDE COUNTY

Chuckawalla Mountains, 8 miles south of Desert Center

Two parallel veins, known as Roosevelt and Rainbow, occur in granodiorite, about 600 feet apart. The Roosevelt vein strikes east and dips 50° S.; Rainbow vein strikes east, and dips 50° N. Width of veins ranges from 2 to 8 feet.

Development on the Roosevelt vein consists of incline shaft sunk on the vein to a depth of 96 feet. About 100 feet west of this shaft, a shaft has been sunk on the vein to a depth of 135 feet. At 60 feet below the collar of the shaft drift west 50 feet and east 20 feet. The vein has been sheared, forming a heavy talcose gouge, mineralized with light flakes of free gold. Assays reported from \$8 to \$100 per ton in gold.

The Rainbow vein is 600 feet north of the Roosevelt vein and is a quartz vein in granodiorite. The vein quartz is mineralized with free gold, associated with pyrite and chalcopyrite. Development consists of a tunnel driven west 130 feet, which has been stoped for a distance of 100 feet to the surface, approximately 50 to 75 feet above tunnel level. The vein mined had an average width of 2 feet, and reported ore milled averaged \$12 per ton in gold.

Bibl.: State Mineralogist's Report XV, p. 541.

Schellenger Mine. This mine comprises 2 claims, Streamliner No. 1 and No. 2, situated on the west slope of Maria Mountains, in sec. 22, T. 4 S., R. 22 E., S. B., 4 miles east of Cox Siding, on the Santa Fe Railroad and 6 miles southeast of Midland; elevation 1100 feet. Owners are T. A. Ashby, Rice, California and M. A. Anderson, Pasadena, California.

A 2-to 3-foot quartz vein on the contact of granite pegmatite and schist strikes east and dips 80° N. The granite hanging wall is cut by pegmatite dikes that strike north; the footwall of the vein is schist. Development consists of two tunnels. The lower tunnel is driven east on the vein 60 feet and about 25 feet in elevation above lower tunnel, the upper tunnel is driven 20 feet east. About 2000 feet east of these workings on the east slope of the mountain there are several shallow shafts sunk on the vein to a depth of 10 feet. On a north trending vein there is a 50-foot shaft. Ore mined and milled from the vein is reported to have a value of \$15 per ton in gold. Idle.

Bibl.: State Mineralogist's Report XXV, p. 487.

Sunrise mine comprises three groups of claims known as the Sunrise group of 15 claims, Cortez group of 3 claims and the Zulu group of 11 claims, the last being located in the Monte Negro district, 6 miles east of the Sunrise claims. The Sunrise claims are in sec. 26, T. 2 S., R. 12 E., S. B., on the southeast slope of the Dale Hills, about 47 miles northeast of Mecca; elevation 1500 feet. Owner is Sunrise Mines, Inc., J. R. Blessing, president; R. C. Hueler, secretary, 416 Electric Building, San Diego. In 1940 the property was under lease to Pinto Basin Mining & Milling Company, J. L. Soske, president; R. C. Beller, secretary, 199 Fair Oaks Avenue, Pasadena, California.

Parallel quartz veins in granite, strike N. 20° W., dip 70° SW. These veins range from 2 to 4 feet in width. The Sunrise shaft is sunk to a depth of 300 feet on an inclination of 75° with levels at 100, 200, and 300 feet.

The last lessee remodeled the mill and treated custom ore until closed by the War Production Board's order L-208. The mill consists of 8-inch by 8-inch jaw crusher, elevator to fine-ore bin; belt feeder to 10-foot Lane mill to Wilfley table, table tails to two 12-foot by 12-foot Door thickeners; 8-foot by 10-foot solution tank; capacity 25 tons. Idle.

Summit Group of Mines. This group comprises 7 claims situated in the Dale mining district, one mile west of Gold Crown mine, in sec. 20, T. 2 S., R. 12 E., S. B., 19 miles southeast of Twenty-nine Palms; elevation 2000 feet. Owner is Jack Meek, Twenty-nine Palms, California.

A series of narrow quartz veins occurs in granite. These veins have a general eastward trend, and vertical dip. They vary in width from 12 inches to 2 feet.

Development consists of a vertical shaft sunk on the south vein to a depth of 20 feet. There are a number of shallow shafts 10 to 20 feet in depth east and west of the main shaft. The vein quartz in these shafts shows hematite with free gold. It is reported to carry from \$20 to \$50 per ton in gold. Idle.

Bibl.: State Mineralogist's Report XXV, p. 488.

Thelma and Desert Gold Group of Claims. This group comprises 5 claims situated in Dale mining district, about one mile east of the Gold Crown mine, in sec. 13, T. 2 S., R. 12 E., S. B., 18 miles southeast of Twenty-nine Palms; elevation 2100 feet. Owner is Jack Meek, Twenty-nine Palms, California.

On Thelma group, a series of narrow quartz veins occurs in granite. The strike is east, width 12 inches to 2 feet. On Desert Gold claims, the quartz veins occur in granite, have a general northward trend. The widths vary from 6 inches to 2 feet. The vein quartz is copper-stained and heavily mineralized with hematite. The hematite shows free gold. Development consists of a number of shallow shafts sunk on veins from 20 to 70 feet in depth. Idle.

Bibl.: State Mineralogist's Report XXV, p. 488.

Victor Mine (El Plomo or Steele) comprising 8 claims, is in sec. 32, T. 4 S., R. 4 W., in the Pinacate mining district. Owners are Calvert and Fultz.

The principal country rock is granitic. The long tunnel, however, is partially in the metamorphics of this area. The walls of the vein are granitic, probably quartz diorite. The vein strikes north, dips 30 to 35° W. It varies in width from 2 inches to nearly 3 feet. Valuable minerals consist of free gold and galena which are frequently rich in silver.

Development consists of a 1200-foot tunnel which intersects a shaft at the 100-foot level. This shaft was sunk 200 feet on 30° inclination. The first 400 feet of the tunnel is a crosscut. The greater part of this work was done in the eighties. In 1935, the property was equipped with a one-stamp mill. Idle.

Bibl.: State Mineralogist's Reports VIII, p. 527; XI, p. 384; XII, p. 225; XIII, p. 314; XXV, p. 489; XXXI, pp. 514-515.

Iron

The most important deposits of iron ore in the southern part of California occur in T. 3 S., R. 13 E. and T. 3 S., R. 14 E., S. B., in the Eagle Mountains, at the northeastern end of Riverside county. The iron-ore deposits of the Eagle Mountains are large and valuable and are now of especial importance due to the operation of the Kaiser steel plant at Fontana, San Bernardino County.

Iron Chief Mine. The numerous bodies of iron ore occur in a belt of sedimentary rocks a quarter of a mile wide which extends over six miles in an easterly direction across the northern part of the Eagle Mountains. These iron-ore deposits are covered by 187 patented mining claims formerly owned by Southern Pacific Land Company; under option to Riverside Iron & Steel Company, Harland Bradt, president and manager, and Foley Bros., St. Paul, Minnesota; under lease to Mineral Materials Company, 1145 Westminster Avenue, Alhambra, California, Claire Dunton, manager.

The east end of the iron deposit was trenched and drilled by the U. S. Bureau of Mines in 1942, W. D. McMillan, mining engineer, in charge of operations. Total tonnage, east and west ends, as estimated by U. S. Geological Survey (Bull. 503) is 70,000,000.

The iron deposits are in secs. 13, 14, 23, 24, 25, 35, and 36, T. 3 S., R. 13 E. and secs. 27, 28, 29, 30, 34, 35, T. 3 S., R. 14 E., S. B., 14 miles northwest of Desert Center and $4\frac{1}{2}$ miles north of Eagle Mountains pumping station on the Metropolitan Aqueduct and 71 miles east of Indio, a station on the Southern Pacific Railroad; elevation 1750 to 1950 feet.

In the eastern part of the Eagle Mountains two beds of iron ore extend eastward, dip 40° N. for about 2 miles. These beds are separated by 200 feet of quartzite and lime-silicate rocks. The iron ores have replaced the beds of dolomite in this part of the district. Farther west, the iron ore occurs in bands and irregular lenses within the dolomite, roughly following the bedding. The estimated tonnage of ore on the North, South, and Bald Eagle deposits was 21,600,000 tons of proven ore averaging 50 percent iron and 10,000,000 tons of probable ore. The North deposit is located on Rodger No. 5, Rodger No. 8, Rodger No. 9, Virginia, and Katie Gray lode claims. Development consists of a tunnel driven southwest 75 feet below outcrop on South deposit. The outcrop of iron is 60 to 100 feet wide and 500 feet in length. North deposit of iron, as indicated by trenches, is 600 feet in width by 1200 feet in length and 300 feet in thickness. Development consists of lower tunnel driven north 150 feet in iron, then a raise to surface a distance of 200 feet in ore. At 100 feet in elevation above lower tunnel, upper tunnel is driven north 75 feet, connecting with raise from lower tunnel.

The Bald Eagle deposit is located west of South and North iron deposits. The surface outcrop of iron ore is 1500 feet in length and 70 feet thick. Development consists of an open cut 100 feet in width and 40 feet high, with two benches 20 feet high. This cut exposes orebody 70 feet in thickness. The ore is predominantly hematite but here and there consists of magnetite. The ore from open cut is loaded into trucks by steam shovel with $\frac{3}{4}$ -yard bucket; hauled to crushing and screening plant with a capacity of 500 tons per 8-hour shift. Ore from trucks to hopper, then to 16-inch by 18-inch jaw crusher, crushed to $2\frac{1}{2}$ -inch size, then by 36-inch conveyor belt to shaking screen; screened to 1-inch to $2\frac{1}{2}$ -inch

size, to bin. The minus 1-inch size goes to second vibrating screen and is screened to $\frac{1}{4}$ -inch to 1-inch size; through size to bin and oversize returned to crusher. Plant is driven by caterpillar diesel engine.

Mine equipment consists of 300-cubic-foot Gardner-Denver compressor. The crushed ore is hauled by trucks with a capacity of 25 tons to Indio, a distance of 71 miles, where trucks dump into hopper on siding, then loaded by conveyor into gondolas for shipment to California Ship Building Company, Wilmington, California. The ore is used for ballast on Liberty ships. Forty thousand tons of ore has been shipped to date. Analysis: 50 percent iron, 11 percent silica, 0.08 percent phosphorus, 0.2 percent sulphur. Thirty men are employed.

Bibl.: State Mineralogist's Reports XV, pp. 544-545; XX, p. 196; XXV, pp. 489-491; U. S. Geological Survey Bull. No. 503; War Minerals Rept. 97, U. S. Bureau of Mines.

Maria Mountains Iron Deposit. Two claims known as Iron Cap No. 1 and Iron Cap No. 2 are situated in Maria Mountains, in T. 4 S., R. 22 E., S. B., 8 miles southeast of Cox, a siding on the Santa Fe Railroad. Owner is J. O'Connell, Blythe, California.

The iron occurs as a capping on a peak of dolomitic limestone. The ore is hematite and magnetite. It is inaccessible as to roads.

Palen Mountain Iron Deposit. This deposit comprises 3 claims, the Iron Cap, Iron King No. 1, and Iron King No. 2, located on the south slope of the Palen Mountains, in sec. 22, T. 5 S., R. 18 E., S. B., 15 miles north of Highway 60 and 30 miles northwest of Blythe. Owners are Jack O'Connell and C. J. Hill, 437 North Oakhurst, Beverly Hills, California.

A small deposit of magnetite occurs in lime-silicate rocks on contact with granite. The vein of ore strikes east, dips 60° S.; width 20 feet and length 300 feet. The deposit is developed by three open cuts. About 2 miles west of this outcrop of magnetite, there is another exposure 20 feet in width and 200 feet in length. Samples from these two deposits are reported to carry 70 percent iron. Idle.

Lead-Silver

Black Eagle Mine. The property comprises 7 patented claims and 3 unpatented claims, totaling 200 acres, situated in the Eagle Mountains, in sec. 25, T. 3 S., R. 13 E., S. B., 22 miles northeast of Cottonwood Springs and 50 miles by road northeast of Indio, a station on the Southern Pacific Railroad; elevation 2100 feet. Owner is Imperial Metals, Inc., S. B. Mosher, president; C. L. Larzelere, secretary, 811 West Seventh Street, Los Angeles.

There are two veins on the property, known as the Black Eagle and the South veins. The South vein intersects the Black Eagle about 1000 feet west of the shaft. The Black Eagle vein occurs along the contact of quartzite and diorite. Strike is N. 70° W., dip 85° N. Width is 4 to 10 feet, average 6 feet. The South vein strikes N. 30° E., dips 80° NE. Width is 6 to 8 feet. The principal development work has been confined to the Black Eagle vein. A two-compartment shaft has been sunk on the vein to a depth of 650 feet, with levels at 60, 100, 150, 200, 300, and 500 feet. On the 60-foot or tunnel level, drift west 600 feet and east 160 feet; on 150-foot level, drift west 500 feet and east 180 feet; on 200-foot level, drift west 200 feet and east 180 feet; on 300-foot level, drift



CRUSHING AND SCREENING PLANT OF MINERAL
MATERIALS COMPANY ON EAGLE MOUNTAINS
IRON DEPOSIT, RIVERSIDE COUNTY

Located 14 miles northwest of Desert Center

west 485 feet, then crosscut south 550 feet to South vein, with drift southwest 170 feet. This vein is 6 feet in width. Vein quartz is mineralized with copper carbonates and reported to carry \$6 per ton in gold. On the 150-foot level three ore shoots were developed. The lengths were 50, 100, and 180 feet; the average width, 6 feet. These individual shoots have been stoped to the 60-foot level. The shaft is in diorite hanging wall from the 500-foot level to the 600-foot level.

The mine has been operated off and on from 1924 to the latter part of 1940. In the early part of 1939, a 100-ton concentration and flotation plant was installed on the property. The plant was operated from July 1939 to January 1940, treating 75 tons per 24 hours. During this period, the value of concentrates shipped was \$53,706. The average heads treated were gold 0.39 ounces, silver 8.30 ounces, lead 13.6 percent, copper 4.5 percent. Ratio of concentration 9.5 to 1. Recovery by table concentration is reported as 51.6 percent, by flotation at 74.4 percent.

Concentrates and ore shipped from the property from 1935 to 1940 were as follows:

Year	Copper		Lead		Silver Value
	Pounds	Value	Pounds	Value	
1935 -----	2,073	\$172.00	15,303	\$616.00	\$1,953.00
1936 -----	6,355	525.00	53,983	2,483.00	4,269.00
1938 -----	15,044	1,479.00	241,510	11,109.00	3,387.00
1939 -----	68,683	7,143.00	634,071	29,801.00	11,604.00
1940 -----	22,269	2,516.00	536,047	26,823.00	22,510.00

Total production of the property has been \$200,000. Operations were suspended December 1940 and all mine and mill equipment removed from the property. Idle.

Bibl.: State Mineralogist's Reports XX, pp. 193-196; XXV, pp. 474-476; XXXVI, p. 47.

Corona Lead-Zinc Mine. This mine comprises 5 claims situated on a ridge between Eagle Canyon and Gypsum Canyon, in sec. 14, T. 4 S., R. 7 W., S. B., 4½ miles south of Corona; elevation 1600 feet. Owners are Joe Smith, Temecula, California, and Fred Spiess, Corona, California; under lease and option to Corona Lead-Zinc Company, Victor Mishelle, president and manager, West Los Angeles, California.

A deposit of oxidized lead-zinc ore occurs in marine metasedimentary rocks. Strike of vein is northeast, dip 45° NW. Width of vein varies from 2 to 6 feet but mineralization extends over 15 feet. Development consists of open cut 360 feet in length. At 310 feet in elevation below open cut, a crosscut tunnel is being driven N. 15° W. to intersect vein exposed by open cut. This tunnel has been driven 92 feet. The country rock in face of tunnel is mineralized with pyrite. About 300 feet west of crosscut tunnel, there is an open cut and two short tunnels driven on a parallel vein. Ore mined from the open cut and tunnel is antimonial lead ore reported to assay 10 percent lead, 14 percent antimony and 40 ounces in silver per ton.

Mine equipment consists of 90-cubic foot American Pneumatic Tool Company compressor. Mill equipment consists of 12-inch by 24-inch jaw crusher, driven by 24-horsepower motor; 75-ton ore bin, 6-inch by 8-inch jaw crusher, driven by 40-horse power Ford auto gas engine; bucket elevator to 75-ton ore bin, then by belt feeder to roller mill, capa-

city $1\frac{1}{2}$ tons per hour; screened to 40-mesh, then to two concentration tables; middling product from tables to Lamley jig, tailings to waste.

Water supply is secured from reservoir in canyon west of mine. Capacity of reservoir is 18,000 gallons. From reservoir to mill, pipe line consists of 1800 feet of $1\frac{1}{4}$ -inch pipe. Idle.

Desert Center claim is in the Chuckawalla Mountains, in sec. 35, T. 6 S., R. 17 E., S. B., 16 miles east and about 8 miles south of Desert Center. Last known owner is S. A. Ragsdale, Desert Center, California.

Here a 3-foot vein is associated with a basic dike in granite. Strike is east, dip about 30° S. Galena occurs in occasional bunches which carry a little gold and a few ounces of silver. Development consists of a 25-foot shaft and a 75-foot crosscut with 20 feet of drifting. Idle.

Bibl.: State Mineralogist's Report XXV, p. 491.

Neal group of 2 claims is in the Maria Mountains in sec. 25, T. 3 S., R. 21 E., S. B., about 19 miles north of Blythe and $3\frac{1}{2}$ miles east of the Santa Fe Railroad track.

It is reported that lead-silver-copper minerals occur in a felsitic dike in limestone. The dike is 50 feet wide; strike northwest, dip northeast.

Development consists of a 60-foot shaft and 100 feet of tunnel work. No information on values is available. Idle.

Bibl.: State Mineralogist's Report XXV, p. 491.

Palisades group of 3 claims is in sec. 4, T. 6 S., R. 4 W., S. B., 2 miles north of Elsinore.

Narrow stringers in schist near the granite contact strike N. 60° E., dip 60° E. These stringers are reported to carry spotted values in lead, silver, copper, and gold. Idle.

Bibl.: State Mineralogist's Report XXV, p. 491.

Manganese

Commercial deposits of manganese ores have been found in several localities in Riverside County. The most important of these is the Ironwood mining district in the eastern part of the county. This district includes the Maria, Little Maria, McCoy, and Palen mountains, extending westward from the Colorado River, and from 20 to 25 miles north of Blythe. Some shipments have been made from the Palo Verde area in the southeastern part of the county near the Imperial County line, and from the Elsinore area.

In a previous report³ an error was made concerning production from these areas. The statement of production in 1918 was given as "152,693 tons"; this should be 3791 tons valued at \$152,693. Likewise for 1919, it should be 1808 tons valued at \$49,324, instead of "49,324 tons".

During the present war the Arlington (Black Jack) mine alone has produced approximately 10,000 tons, ranging from 20 to 42 percent manganese.

Production in the county has practically ceased due to specifications of the Metals Reserve Company which became effective in the early part of 1945 and which few if any of these deposits could meet.

³Tucker, W. B., and Sampson, R. J., Riverside County: California Div. Mines Rept. 25, p. 468, 1929.

Arlington (Black Jack) manganese mine, comprising 14 claims, is in secs. 13 and 24, T. 4 S., R. 19 E., S.B., on the east slope of the McCoy Mountains, 9 miles west of Cox Siding on the Santa Fe Railroad branch line from Rice to Blythe. Owners are Fred W. and Walter Kroger, in the 500 block, Second Street, Pomona, California, and Lewis I. Buck et al., Monrovia, California; under lease to Arlington Manganese Company, A. B. Miner, general partner, 11143 Washington Boulevard, Culver City, California.

This deposit has been the most productive and has been more extensively worked than any other manganese deposit in southern California. In 1917-1918 it produced about 3000 tons, reported to have averaged 45 percent manganese. Since February 1942, one hundred and seventy cars, approximately 8500 tons, from 20 to 42 percent manganese, have been shipped. Of these last shipments, 165 cars went to the Kaiser steel plant at Fontana and 5 cars to Metals Reserve Company.

The deposits are near the foot of the east slope of the McCoy Mountains at their north end. They occur in a series of roughly parallel fissures in quartz porphyry. The strike varies from about N. 15° W. to N. 10° E.; dips vary from 60° E. to 70° W. Widths range from 4 to 20 feet. The ore, which is largely psilomelane, occurs in streaks from 18 inches to 4 feet wide, and mixed with the brecciated wall rock which incases the higher-grade material.

The deposits have been opened by several open cuts and short tunnels as well as two principal working places. On one of these a tunnel has been driven south about 350 feet with a 150-foot winze 90 feet from the portal. The last 150 feet of tunnel was driven by the present operator, who shipped 10 cars of ore from a stope 40 feet long, 6 feet wide, and 40 feet high. It is reported that there is from 18 inches to 2 feet of high-grade ore in the bottom of the winze. About 1500 feet southeast of these workings, an underhand stope 125 feet long, 6 to 20 feet wide, and about 60 feet deep, has been worked from the surface. For some reason which is not now apparent, the ore was cut off along the entire length of the shoot at this depth. It is reported that at or near the bottom the ore was found in nodules surrounded by clay. This condition suggests a fault but the operators were unable to determine this and the bottom of the stope is now covered with loose rock. They now intend to move their equipment and work on an outcrop south of the old workings described above. The ore is hauled by truck 9 miles east to Inca (Cox) Siding on the Santa Fe Railroad.

Equipment consists of two portable compressors, double drum gasoline hoist with overhead bucket tram at the underhand stope, diesel lighting plant at the camp which consists of 5 houses. Normally, 12 to 15 men are employed.

Bibl.: State Mineralogist's Reports XV, p. 545 (under name of Black Bird); XXV, p. 492; Bull. 76, pp. 54-56.

Big Bullett manganese claims comprise 20 claims situated in the Orocopio Mountains, in sec. 5?, T. 7 S., R. 11 E., S.B., 5 miles southeast of Shavers Well, and 15 miles east of Mecca; elevation 1600 feet. Owner is Leland Noblitt, Brawley, California.

Irregular outcrops of manganese occur in schist, paralleling the schistosity; strike north, dip 50° E. Development consists of open cut 20 feet in length by 8 feet in depth. About 10 tons of manganese oxides

have been mined from open cut reported to carry 30 percent manganese. Two men are employed.

Black Eagle and Newport manganese mines comprise 2 claims located as Black Eagle and Newport, situated in the Elsinore district, in the W $\frac{1}{2}$ sec. 23, T. 5 S., R. 4 W., S.B., 6 miles northeast of Elsinore. Owners are C. S. Beal and R. W. McClellan, Elsinore, California.

The manganese occurs as a bedded deposit of oxidized rhodonite in chert in Triassic slates. The ore developed is from 18 inches to 3 feet in width. Development consists of open cuts and a shaft 70 feet in depth.

Several cars of ore shipped to the steel plant of Kaiser Company, Inc., Fontana, California, were reported to carry from 30 to 35 percent manganese. Idle.

Box Canyon Manganese Deposit. This deposit comprises 2 claims situated on the northeast slope of the Mecca Hills, on ridge north of Box Canyon, in sec. 24, T. 6 S., R. 10 E., S.B., an eighth of a mile west of Shavers Well, and 12 miles northeast of Mecca; elevation 1500 feet. Owner is Leland Noblitt, Brawley, California.

Irregular nodules of manganese occur along the strike of the schist; strike N. 60° W., dip 47° NE., width 18 inches to 2 feet; not over 20 feet in length where exposed in the canyon. The manganese is in the form of pyrolusite and psilomelane, and carries from 10 to 30 percent manganese, and a large amount of silica.

The development consists of shallow open cut 20 feet in length. Idle.

Elsinore manganese deposits lie 6 miles northeast of Elsinore in secs. 23 and 24, T. 5 S., R. 4 W. Last known owner is Charles P. Carter, Elsinore, California.

There are two parallel veins in granite and schist. The principal one outcrops some 1500 to 2000 feet distant from and 400 to 500 feet above the Santa Fe Railroad tracks.

Although the deposits have long been known no development work has been done on them. Idle.

Bibl.: State Mineralogist's Report XV, p. 546; XXV, p. 493; Bulletin 76, p. 58.

Langdon manganese deposit, comprises 9 claims, known as Blue Chief No. 1 to No. 7, Manganese No. 6 and Langdon No. 9, situated in the Little Maria Mountains, adjoining U. S. Gypsum Company's property on the east, in sec. 8, T. 4 S., R. 21 E., S. B., 2 miles south of Midland and 20 miles northwest of Blythe; elevation 1100 feet. Owner is C. M. Langdon, Bell, California.

Three parallel veins of manganese occur in limestone. The veins strike N. 15° W., dip 35° W.; width 3 feet. Development consists of several open cuts and short tunnels. One tunnel is driven S. 15° E. It is 50 feet in length and shows about 10 feet of ore, with a horse of limestone in the face. The ore on the three principal dumps consists of manganite, pyrolusite, and psilomelane. During the early part of 1944, claims were under lease to J. Figueroa, who made several small shipments of ore to Metals Reserve Company's stockpile at Parker, Arizona. Ore shipped is reported to carry 35 to 40 percent manganese with 8 percent silica. Idle.

Tin

The Temescal tin deposit was discovered about 1853 and in 1860 a company was formed to develop it. The outbreak of the Civil War in 1861 caused this company to suspend operations. The San Jacinto Tin Mining Company was organized January 2, 1868. This company acquired the Rancho Sobrante de San Jacinto, a Spanish grant, comprising 49,000 acres of land on which is located the Temescal mine. The deposit was acquired and worked by an English syndicate from 1880 to 1892. During this period 10,000 tons of ore was extracted from the mine which is said to have averaged 4 percent tin oxide.

The production in 1891 was 125,289 pounds of tin, valued at \$27,564. In 1892 the production was 126,000 pounds, valued at \$32,400, making a total production of 251,289 pounds, valued at \$59,964.

Geological Features

The area from which the tin was recovered is five miles south of Arlington in the western portion of the Rancho Sobrante de San Jacinto. Tin ore is found in the tourmaline veins from Cajalco Hill to a point about two miles south. In the vicinity of Cajalco Hill there is a semicircular area of granite over two miles in diameter, partly surrounded, on the northwest and south, by porphyry and adjoining on the east a great body of granitic rocks. Traversing the granite in a northeasterly direction are black tourmaline veins which form the gangue of the tin ore, when it is present. There are two varieties of tin ore; the yellow, occurring in thin layers in a non-crystalline form, and the brown, in granular form in massive specimens, or in small, clear, reddish-brown crystals lining cavities. There are also occurrences of tin in tourmaline veins in granite, in the vicinity of Perris and Elsinore. The American Tin Corporation acquired the Temescal tin mine and other properties on the Rancho Sobrante de San Jacinto in the early part of 1927 and spent a large amount of money in exploration work on various of the tourmaline veins on the property.

For a description of the above operation and a subsequent one, see Temescal tin mine.

Deposits

*Black Rock Deposit.*⁴ It comprises 400 acres located in secs. 18 and 19, T. 4 S., R. 5 W., S. B., 2 miles southeast of Cajalco Hill on the Rancho Sobrante de San Jacinto and 7 miles south of Arlington; elevation 1400 feet. Owner is W. B. Moore, Moore Bros., 711 Baker Building, Walla Walla, Washington.

Twelve tourmaline veins occur in the granite on this property. The general course of these veins is northeast; they dip 60° SE. The widths of the veins vary from 4 to 30 feet. It is stated that samples taken from the outcrops of these veins carried traces of tin. Some of the vein outcrops are stained with copper minerals.

Development consists of incline shaft sunk to a depth of 125 feet and it is planned to sink this shaft to 200 feet before drifting on the vein. It is also stated that at this depth the other parallel veins will be developed by crosseuts. Idle.

⁴ Description of the Black Rock deposit is reprinted from Report XXV of The State Mineralogist, pp. 495-496.

Chief of the Hills Group. This group of 5 claims in sec. 4, T. 6 S., R. 4 W., S. B., on top of a hill 2 miles northeast of Elsinore was located in 1926 by J. M. Mack, Clay L. Berry, and Mary Briner, all of Elsinore, California; now in public domain.

A belt of slate, schist, and felsites, having an approximate width of 2000 feet, forms a lens 4000 feet long in the granite. The rocks in this belt strike N. 30° W. and dip 80° E. In this series there are five principal vein dikes having the same strike and dip as the enclosing rocks. These dikes, which consist of fine-grained granite, have been replaced in part by minutely crystalline tourmaline. At these points tin has been reported as occurring in amounts varying from 0.30 to 2.21 percent. The only form observed was reddish-brown crystals, lining cavities in the tourmaline. On one of these vein dikes a shaft has been sunk to a depth of 100 feet. At the bottom it is reported that a crosscut has been driven 20 feet to the east and 10 feet to the west of the shaft. The west crosscut, according to reports, was driven in material which assayed from 0.31 to 1.22 percent tin. Idle.

Bibl.: State Mineralogist's Report XXV, p. 496.

Holmes Ranch Deposit. The ranch consists of 560 acres located in sec. 12, T. 4 S., R. 6 W., S. B., 1½ miles southeast of Cajalco Hill and 5 miles south of Arlington. Owner is Lawrence Holmes, Arlington, California.

On the northwest portion of sec. 12 there is a tourmaline vein in the granite which strikes northeast. The vein outcrop is from 6 to 15 feet in width and can be followed on the surface for a considerable distance. It is reported that samples taken at intervals along the outcrop showed traces of tin with some assays going as much as 0.30 percent. Idle.

Bibl.: State Mineralogist's Report XXV, p. 496.

Moore deposit is in a 600-acre ranch in secs. 13, 14, 23, and 24, T. 4 S., R. 6 W., S. B., about 2 miles southeast of Cajalco Hill and 7 miles south of Arlington. Owner is Robert L. Moore estate, Riverside, California.

A series of parallel tourmaline veins traverses the granite in a northeasterly direction. Development consists of several shallow shafts 20 to 40 feet deep on different veins. On the west end of the property, in sec. 13, at the contact of granite and porphyry, copper oxides occur. Chalcopyrite is disseminated in the granitic wall. Samples taken along the outcrop are said to carry from 2 to 5 percent copper. Idle.

Bibl.: State Mineralogist's Report XXV, pp. 496-497.

South Black Rock deposit is in an 80-acre tract in sec. 19, T. 4 S., R. 5 W., S. B., about 3 miles southeast of Cajalco Hill and 7 miles south of Arlington; elevation 1500 feet. Owner is Hewitt S. West; address unknown.

Eight parallel veins of tourmaline occur in the granite. These veins have a general course of N. 30° E. and dip to the southeast. The widths of the veins vary from 6 to 10 feet. Samples taken from the outcrops are said to carry from 0.13 to 0.50 percent tin.

Development consists of several shallow shafts sunk on the vein outcrops, the deepest being 25 feet. Idle.

Bibl.: State Mineralogist's Report XXV, p. 497.

Temescal Tin Mine (Cajalco). This property is in the western part of Rancho Sobrante de San Jacinto, about 5 miles southeast of Corona. Holdings comprise 870 acres, located in secs. 2, 3, 10, and 11, T. 4 S., R. 6 W., S. B. The property was acquired in March 1927 by the American Tin Corporation, G. H. Bryant, president. For the next three years it was intensively developed by this company. Present owner is Tineco Corporation, Chas. V. Williams, Jr., American Building, Richmond, Virginia.

The country rock is a coarse-grained, hornblende-biotite granite. Tin occurs as cassiterite in tourmaline veins in the coarser-grained granite. There are known to be 65 of these veins, 10 of which have been explored. They vary from one inch to 15 feet in width. The general course of the veins is northeast and they dip from 55° to 75° northwest. The vein matter does not consist wholly of tourmaline but contains some quartz grains scattered through it in the same proportion as in the granite.

The tin is not found to any extent in the quartzose gangue. Samples taken from the outcrop of the various veins show an average of 0.03 percent tin. Some samples carried as high as 2 percent tin. Ten of these parallel veins have been more or less developed by tunnels and shafts and have been stripped for a considerable distance along their outcrops.

The main development is confined to No. 1 vein which is on Cajalco Hill. Former operators explored this vein by two shafts sunk to a depth of 180 feet. The main orebody lay in the center of these workings and extended downward 300 feet on the dip. This orebody, known as the Cajalco, had a maximum width of 15 feet, with an average width of 6 feet. It was 300 feet in length. The ore extracted averaged 4 percent tin oxide.

No. 1 shaft has been sunk to a depth of 650 feet on an incline of 65° . The shaft encountered the above-mentioned orebody at a depth of 100 feet. Seven levels were driven on the vein about 65 feet apart. No. 1 level, the adit tunnel level, is 270 feet in length. On No. 2 level there is a drift 360 feet southwest of the shaft and 200 feet northeast; No. 3 level, 560 feet southwest and 200 feet northeast; No. 5 level, drift 500 feet; No. 6 level, drift 500 feet. A crosscut was driven south on the No. 7 level to cut the different veins.

Development work below the 300-foot level was disappointing in that it failed to find the downward extension of the orebody worked above that level. Also, no commercial ore was developed in any of the workings below the 300-foot level. No. 2 vein, which is about 600 feet south of No. 1 vein, has been prospected by a shaft 75 feet deep. No. 4 and No. 5 veins were prospected by a shaft 180 feet deep. At a depth of 100 feet some copper and silver ore was encountered. The vein material contains chalcopyrite and pyrite and is said to carry 2 percent copper and one ounce of silver. On the 170-foot level on No. 4 vein, a drift has been driven southwest 300 feet. No. 9 vein is one mile southeast of No. 1 shaft. There is a tunnel driven southwest on this vein 500 feet. This vein has an average width of 4 feet. Samples taken at intervals along the vein show a trace to $1\frac{1}{2}$ percent tin oxide. The other veins have been prospected by shafts sunk to depths of from 75 to 100 feet. This development work ceased in 1930. During this period the mine was well supplied with modern equipment and a 10-ton pilot mill.

In 1942, Dodge Construction Company of Fallon, Nevada, secured a government loan for the purpose of working the surface vein matter. A modern 100-ton mill was erected and 1400 tons of this surface material was put through *with a recovery of less than one pound of tin oxide per ton.* Idle.

Bibl.: State Mineralogist's Reports IV, p. 120; XI, pp. 111-113; XV, pp. 547-550; XXV, pp. 497-499.

Tungsten

Blue Boy and Black Mountain Group of Tungsten Claims. This group comprises 4 claims known as Blue Boy, Blue Boy No. 1, Black Mountain, and Black Mountain No. 1, situated in San Jacinto Mountains, one mile west of Twin Pines Ranch, in sec. 3, T. 4 S., R. 1 E., S. B., 8 miles south of Banning; elevation 3500 feet. Owner is J. O. Mayall, Santa Ana, California.

On Blue Boy claims an outcrop of tautite occurs in schist, strike east, dip 40° S. Width is 2 to 4 feet. Length of outcrop along strike is approximately 50 feet. Development consists of open cut 12 feet in length and 5 feet in depth. Vein material consists of garnet, epidote and schist, mineralized with scheelite. Ore is reported to carry 1 percent WO_3 . On Black Mountain claims there are small exposures of tautite in schists; strike northeast. Width is 2 to 4 feet, length of exposures 30 feet. Development consists of shallow open cuts and shaft 10 feet in depth. Twelve tons of ore extracted from workings on Black Mountain claims is reported to have assayed 6 percent WO_3 . Idle.

Bibl.: State Mineralogist's Report XXXVII, p. 582.

Garnet Queen Tungsten Mine. This mine comprises 3 claims on the west slope of Santa Rosa Mountains, in sec. 20, T. 7 S., R. 5 E., S. B., 30 miles southwest of Indio; elevation 6000 feet. Owners are Santa Rosa Tungsten Mines, Inc., Gen. Walter P. Story, H. R. Galinor, and Jack Harris, 430 Walter P. Story Building, Los Angeles.

Two parallel tautite exposures occur in granite and schists. The Garnet Queen vein strikes N. 80° E., dips 70° S.; width 2 to 6 feet. The vein material is garnet, epidote, and quartz, mineralized with scheelite. Ore milled is reported to assay 0.7 to 1 percent WO_3 . About 300 feet south is another exposure of tautite which is parallel to Garnet Queen in granite. Development consists of open cuts on the two veins. On Garnet Queen vein the open cut is 50 feet in length by 10 feet in depth. Idle.

Bibl.: State Mineralogist's Report XXXVII, p. 582.

Chuckawalla Tungsten Mine. This mine comprises 2 claims located as Chuckawalla and Happy Jack, situated in the Chuckawalla Mountains in sec. 32, T. 6 S., R. 16 E., S. B., half a mile west of Corn Springs, 9 miles southeast of Desert Center; elevation 2500 feet. Owners are Sam Rose and E. Johnson, Desert Center, California.

A vein occurs on contact of granite and limestone, strike northwest, width 3 feet. It is reported to carry 2 percent WO_3 . Development consists of a tunnel 50 feet in length and a shaft 30 feet in depth. Idle.

Indian Tungsten Mine. This mine comprises 2 claims located as the Indian and Mint lode claims, situated in the Santa Rosa Mountains, in sec. 28, T. 7 S., R. 5 E., S. B., 6 miles south of Pinyon Flat and 20 miles southwest of Indio; elevation 7000 feet. Owner is Elmer E. Dunn, Pinyon Flat, California.

Scheelite occurs in tactite in a garnet-epidote gangue. The tactite body is 60 feet in width and about 600 feet in length; strike east, dip 88° N. Development consists of a crosscut tunnel driven south 150 feet. Idle.

Magnesium Canyon Tungsten Mine. This mine comprises 3 claims located as Cottonwood No. 1, Cottonwood No. 2, and Cottonwood No. 3, situated in and on the ridge northeast of Magnesium Canyon on the northeast slope of the San Jacinto Mountains, in sec. 22, T. 5 S., R. 5 E., S. B., 15 miles west of Indio and 11 miles southeast of Palm Springs; elevation 1600 to 1850 feet. Owners are Mr. and Mrs. Milton L. Knapp, Palm Springs, California. The deposit was discovered in April 1941 and three claims were located along outcrops of tactite. It was under option to T. J. Young, Los Angeles, from the latter part of 1941 until 1943. Mr. Young did considerable development work on the claims in the form of trenches and shallow shafts.

The tactite occurs as a series of beds in granite; strike N. 15° W., dip 15 to 20° SW. Thickness of the beds varies from 6 to 13 feet. On Cottonwood No. 1 claim, at the head of Magnesium Canyon, a bed of tactite is exposed on both walls of the canyon. The exposure of tactite is about 300 feet in length and has a thickness of 3 to 6 feet. Scheelite occurs associated with quartz, epidote, and garnet; developed by several open cuts on the north side of the canyon. Samples taken from these open cuts are reported to assay 1 to 1.5 percent WO_3 . On Cottonwood No. 2 claim, which is located north of Cottonwood No. 1, and 200 feet in elevation above Magnesium Canyon, there is a bed of tactite exposed on the surface, the exposure being 100 feet in length by 60 feet in width, with a thickness of 13 feet. It is estimated to contain 7000 tons.

Development consists of four trenches cut at 25-foot intervals along the strike of the lode to depths of 6 feet. Three trenches run at right angles to the lode with depths ranging from 4 to 18 feet. In the center of this system of trenches there is a shaft 25 feet deep exposing 18 feet of vein material. This shaft cut the footwall granite at a depth of 18 feet. Samples taken from the trenches and shaft are reported to assay 0.8 to 1 percent WO_3 . Idle.

Bibl.: State Mineralogist's Report XXXVII, pp. 582-583.

Matilda group of 7 claims is on the southwest slope of the Chuckawalla Mountains, in sec. 28, T. 7 S., R. 15 E., S. B., 12 miles west of Desert Center and some 14 miles south of the Blythe highway. Owner is E. G. Sweeney, 355 Norton Street, Long Beach, California.

Here the mica schist country rock has been intruded by diorite dikes which are in part also schistose. There are also some short, light-colored dikes, almost as wide as they are long. They appear to consist of quartz and feldspar, with or without mica. They are usually not over 150 feet long. At or near the contact of the diorite and the schist are found zones of quartz and epidote with some garnet. The

scheelite occurs in these. The deposits strike northeast, dip about 45° NW. One of these deposits where opened on the top of a ridge has a schist hanging wall and a diorite footwall. In the small open cut it is 3 feet wide and shows good values under the violet-ray light. This particular zone is traceable for about 500 feet. One of the diorite dikes shows large scheelite crystals ($\frac{1}{2}$ -inch or more) scattered along a distance of 600 or 700 feet.

Since the deposit was visited, shipments have been made to the Metals Reserve Company's stockpile at Parker, Arizona, which are reported to have averaged better than 2 percent WO_3 . Idle.

Miller Ranch Tungsten Deposit. The property comprises 160 acres in Martinez Canyon, in the Santa Rosa Mountains, in sec. 2, T. 8 S., R. 6 E., S. B., 24 miles southwest of Indio. Owner is J. C. Miller, Haynes, California.

Ore occurs as tactite on granite-limestone contact. Development consists of 20-foot shaft and a tunnel 56 feet in length. Width of ore developed is from 2 to 7 feet. Samples taken from these workings are reported to assay 1 percent WO_3 . Idle.

Bibl.: State Mineralogist's Report XXXVII, 583.

Pawnee (Carr) Mine, comprising 4 claims, is in sec. 31, T. 8 S., R. 3 E., S. B., on the south slope of Beauty Mountain, 6 miles northeast of Oak Grove and 9 miles from Aguanga; elevation 4000 feet. Owners are Emerson L. Carr and Wm. Carr, Aguanga, California.

The deposit is of the contact metamorphic type, occurring at the contact of granite and crystalline limestone. Its strike is N. 40° E., dip vertical. The scheelite occurs in a garnetiferous gangue. The width of the ore varies, the maximum being about 8 feet. The shoot, as opened on the surface, is approximately 70 feet long.

Development work consists of 150-foot vertical shaft with a tunnel level about 30 feet below surface and other levels at 90 feet and 140 feet. About 100 feet of drifting has been done on each of these levels. On the surface a glory hole 70 feet long by 6 to 8 feet wide has been connected with the tunnel level by raises. On the 60-foot level there is a stope 30 feet long and 6 feet wide.

Mill on the property consists of 10-inch by 20-inch jaw crusher to 9-inch by 16-inch jaw crusher, elevator to bin; another elevator to 20-mesh vibrating screen, oversize to impact crusher, elevator to screen, screenings to 2 jigs to 2 small tables. Capacity about 100 tons per day. Idle.

Bibl.: State Mineralogist's Report XXXVI, p. 48.

Phoenix Tungsten, comprising 640 acres of patented land, is on the southeast slope of the San Jacinto Mountains, in Andreas and Murray Canyons, sec. 9, T. 5 S., R. 4 E., S.B., about 7 miles southeast of Palm Springs. The property is owned by Andreas Canyon Club, Inc., of Palm Springs, California; leased to Jas. R. Maynard and Henry B. Tuttle, 135 Palo Verde Street, Palm Springs.

The scheelite occurs in a ridge between Andreas and Murray Canyons. This ridge, which rises about 1000 feet above the bottom of each canyon, is very precipitous on the Andreas Canyon side. The country rock consists of granite, limestone, and some mica schist. The limestone occurs as thin, short remnants, largely altered to garnet and epidote.

The strike is northeast, dip 45° SE. The sporadic outcrops of tectite in which the scheelite occurs may be up to 18 feet in width and they are rarely longer. In a distance of about 900 feet along the ridge, there are eight of these outcrops, all of which show splotches of high-grade ore. On the west side of a saddle in the top of the ridge an open cut 35 feet long, up to 15 feet deep, and 22 feet wide, has been made. It is reported that the material in this cut contained high-grade spots as well as values uniformly distributed throughout the mass.

A 20-ton mill consisting of impact crusher, elevator, rolls, trommel to 16-mesh, 3 cone classifiers and 3 tables, with V-8 Ford motor for power, has been moved in and foundations completed. The mill is located about 300 feet above the camp which is in the bottom of Murray Canyon.

Entrance of one of the lessees into military service has stopped the operation.

Pigeon Creek Tungsten Mine. This mine comprises 2 claims located as Burnt Cow and Pigeon Creek, in the Santa Rosa Mountains, half a mile south of Pinyon Flat, in sec. 11, T. 7 S., R. 5 E., S.B., 18 miles southwest of Indio; elevation 4700 feet. Owners are Jack Harris and associates, Los Angeles.

Contact metamorphic deposit on contact of granite and limestone. Strike is northwest, width 10 to 20 feet. Scheelite occurs in epidote-garnet gangue. Development consists of open cut 20 feet in width, 4 to 6 feet in depth, and 40 feet in length. Idle.

Red Cloud Mine. The occurrence of scheelite was discovered in a tunnel on the Great Western claim of the Red Cloud group of mines, situated in the Chuckawalla Mountains in sec. 5, T. 7 S., R. 15 E., S.B., 9 miles south of Desert Center. Owner is J. D. Huston, Los Angeles.

The discovery of scheelite was made by F. J. Scott, Indio, California, in prospecting for tungsten in the Chuckawalla Mountains. With fluorescent light he found scheelite ore on the dump of the tunnel located about 500 feet north of the Great Western shaft. The tunnel is driven N. 30° W., 244 feet on the Red Cloud vein which has a width of 8 feet. At 144 feet from the portal of the tunnel 6 feet of scheelite ore was found on footwall of the quartz vein. Samples cut across 6 feet of ore assayed 1.05 to 1.66 percent WO_3 . The scheelite is evidently associated with a rhyolitic porphyry plug on the contact with quartz-feldspar rock in gneissoid granite. The scheelite was evidently deposited at the same time as the quartz-feldspar rock, and is probably secondary. The ore exposed in the tunnel shows an average width of 6 feet and the contact of rhyolite and quartz-feldspar rock (pegmatite) dips 40° NE. Several other indications of scheelite occur near face of tunnel.

Ribbonwood Tungsten, Inc. Ray Galenor and Geo. Stallman, Walter P. Story Building, Los Angeles, own 6 claims in sec. 26, T. 7 S., R. 5 E., on the northeast slope of the Santa Rosa Mountains, about 18 miles south of Palm Springs; elevation 4500 to 8000 feet; under lease to Lawrence B. Wright and Arthur O. Hall, 206 Sansome Street, San Francisco.

This is a granitic area with a few very narrow mica schist beds. The scheelite occurs in a garnet-epidote-quartz gangue along the contacts. The strike of the deposits on the lower claims varies from due east to N. 50° E.; dip is steep to the west.

Development consists of a 40-foot tunnel near the mountain top which is inaccessible on account of snow. A few tons of ore were shipped to the Parker stockpile from these workings. At an elevation of about 4600 feet on Ribbonwood No. 2 claim, an open cut 10 feet long, 5 feet wide, and 8 feet deep has been made on a lens of ore which is cut off by the granite at the west end of the cut. Shipment from this place is reported to have run better than 2 percent WO_3 .

The lessees were building a road to the top of the mountain but work was suspended until the snow melts. Idle.

NONMETALLIC MINERALS

Riverside County has a great variety of commercial minerals which are used locally and a large tonnage of both industrial and structural materials are shipped into the City of Los Angeles. Commercial deposits of dolomite, granite, and limestone are distributed throughout the county. The Alberhill-Corona district is one of the most important clay-producing areas in the State. Commercial deposits of feldspar and silica occur at various points throughout the county but outside of the production of silica sand, there has been very little activity in the mining of quartz, silica, and feldspar in recent years. There are extensive deposits of gypsum of commercial grade in the eastern part of the county. During World War II there has been an increased demand for gypsum products and the U. S. Gypsum Company's plant at Midland has been enlarged to meet the demand for wallboard and plaster for building defense housing projects, and army and navy camps in California. The wallboard plant of the U. S. Gypsum Company is the largest in the United States. The largest production of gypsum from Riverside County was made during 1941 and 1942. With the conclusion of World War II, there should be increased demand in the valleys of southern California for land plaster as a soil conditioner. This demand should lead to the production of gypsum in the eastern part of the county and the Corona district, that has been held up by the war emergency and the lack of man power. During 1944, there was a small production of acid fluorspar from a deposit south of Rice in the Little Maria Mountains. The deposit is being developed at present and there should be a production of this material in 1945.

Asbestos

Dunn Asbestos Deposit. This deposit comprises 4 claims situated north of Pinyon Flat in the Santa Rosa Mountains, in secs. 32 and 35, T. 6 S., R. 5 E., S.B., 4 miles northwest of Nightingale Camp, on Palms to Hemet highway, and 15 miles south of Palm Springs; elevation 3850 feet. Owner is Elmer E. Dunn, Pinyon Flat, California.

Amphibole asbestos occurs in a belt of serpentine that strikes north and dips 60° E. Two open cuts about 20 feet apart expose slip fibre asbestos, width from a few inches to 12 inches. Open cuts are 20 to 40 feet in length and 15 feet in depth. On Serpentine Hill, in sec. 35, some shallow shafts and open cuts expose narrow seams of amphibole asbestos. Idle.

Percival Asbestos Mine. This mine comprises 4 claims situated north of Pinyon Flat in the Santa Rosa Mountains, in sec. 29, T. 6 S., R. 5 E., S.B., 4 miles northwest of Nightingale Camp, on Palms to Hemet

highway, and 15 miles south of Palm Springs; elevation 4000 feet. Owners, J. Wellman and Jack Harris, Pinyon Flat, California.

Asbestos of the amphibole variety occurs in veins as slip fibre in a granular olivine-hornblende rock, cortlandtite. The longest vein exposed in the main open cut is two feet thick. The cortlandtite belt strikes N. 30° E. and is about 200 feet in width and 1500 feet in length. Development consists of an open cut 150 feet in length by 100 feet in width and 50 feet deep. From the floor of the open cut a series of crosscut tunnels have been driven.

In 1930, about 800 tons was mined and shipped to the Soto Battery Box Manufacturing Company for the manufacture of automobile battery boxes. Idle.

Bibl.: State Mineralogist's Reports XV, pp. 550-553; XXV, p. 499.

Perris Asbestos Deposit. This deposit comprises 35 acres of patented land located in sec. 2, T. 5 S., R. 4 W., S. B., 2 miles southwest of Perris and a quarter of a mile east of U. S. Highway 395, between Perris and Elsinore; elevation 2300 feet. Owner is I. O. Walser, Los Angeles.

Amphibole asbestos occurs along a shear zone in granite. The vein exposed by open cuts is from 6 inches to 2 feet wide.

In 1930, about 100 tons of asbestos was mined and shipped to Soto Battery Box Manufacturing Company, of Los Angeles, for the manufacture of battery boxes for use in automobiles. The deposit is worked out.

Clay

Alberhill Coal & Clay Company, C. J. Biddle, president, 629 South Hill Street, Los Angeles, owns 2200 acres in secs. 15, 22, 23, 24, 25, and 26, T. 5 S., R. 5 W., S. B., in Temescal Canyon, about 4 miles northwest of Elsinore. M. L. Vincent is in charge of mining operations on the ground. Elevations range from about 1270 to 1700 feet.

The clays form a hill some $2\frac{1}{2}$ miles long by 1 mile wide, with an average height of about 400 feet above the valley floor. The axis of this hill trends in a general northwesterly direction. The entire mass, to an unknown depth below the valley floor, is composed of clay of which 36 different kinds have been found on this property. Interbedded with the clays is a lignite coal seam which on this property varies from 3 to 11 feet in thickness. Up to 1895 the company operated the property as a coal mine but after that date the rapid growth and development of southern California created such a demand for clays that the coal operation was abandoned. The general dip of the clays is approximately 10° SW. but locally they may be almost vertical due to folding. There is an overburden of disintegrated granitic material which varies in thickness from nothing to more than 50 feet.

The great variety of clays found here makes them adaptable to many uses, some of which are: fire brick, special refractories, electric furnace refractories, face brick, pressed brick, enameled brick, architectural terra cotta, garden terra cotta, art pottery, chinaware, electrical conduit, drain tile, floor tile, hollow tile, roofing tile, sewer pipe, and saggars.

Generally the fire clays are from 25 to 35 feet thick. No. 3 shale, used principally for sewer tile is 125 feet thick, pink No. 2 is 75 feet

thick. This last is used for mottled building brick. The buildings on the campus of the University of California at Los Angeles were built with this brick. Hill Blue Clay, 6 feet thick, is used principally for heavy, ornamental pottery.

The deposits have been extensively developed, nearly 2,000,000 tons having been mined and sold from within the boundaries of this property. Since the company does not manufacture anything their entire output is sold to other users.

Ten pits have been opened in the hill. The West or Main tunnel pit has been opened by benches for a vertical distance of 300 feet or more, from just above the railroad tracks to practically the top of the hill. The face is approximately 2000 feet long. This pit has been largely worked through the West tunnel by the glory hole method. Drilling is done with 2-inch hand electric drills. Holes are 15 feet deep, sprung and blasted with low-percentage dynamite. Two portable generator sets mounted on trucks supply the power. Generators are driven by 4-cylinder gas engines.

At present the company is shipping about 7000 tons per month, 650 to 700 tons of which is used by the Santa Fe Railroad for fire-box brick. These shipments consist of about 40 railroad cars, the remainder going in trucks to the various users.

At present 14 men are employed. Could use more if they were available.

Bibl.: State Mineralogist's Reports XV, pp. 559-574; XIX, pp. 185-210; XXV, p. 500; XXXI, pp. 65-70; Bull. 38, pp. 221-222; Bull. 99, pp. 163-169.

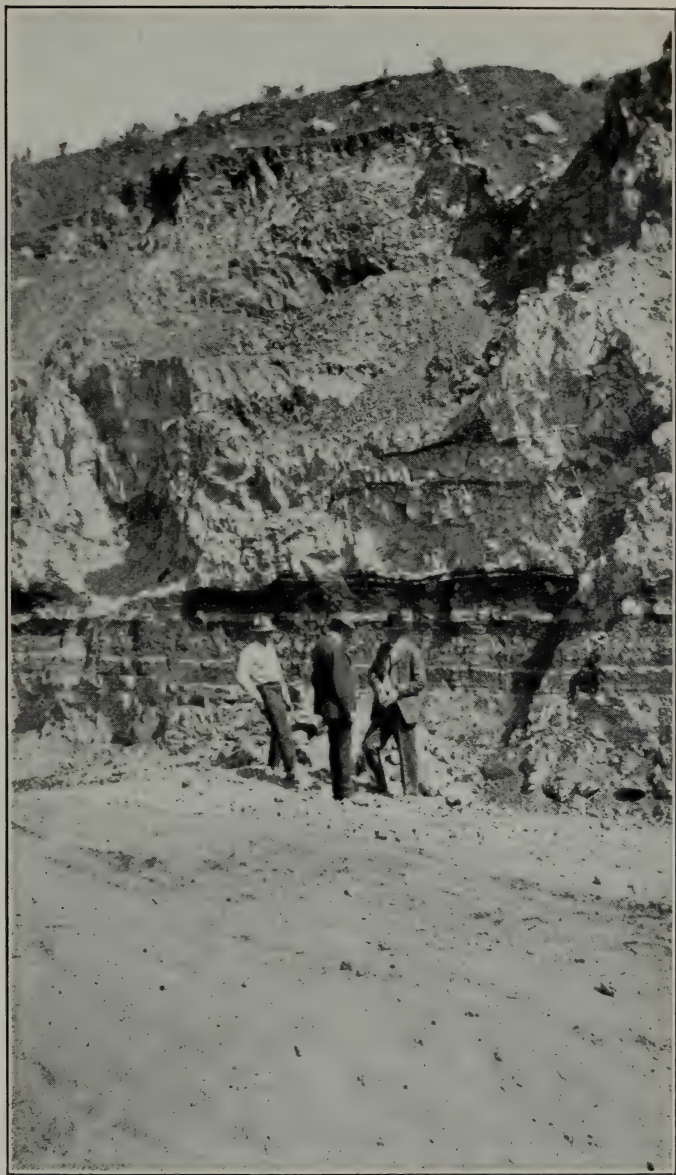
Los Angeles Brick & Clay Products Company, M. C. Riordan, president, 1078 North Mission Road, Los Angeles; Arthur Bodien, superintendent, has 640 acres adjoining the Alberhill Coal & Clay Company's property on the west. It is largely in sec. 21, T. 5 S., R. 5 W., S. B.

The clays here are similar to those found on the Alberhill Company's property. They have been developed by three main pits. The first of these, about half a mile south of the plant, is roughly semicircular, having a face 750 feet long by 130 feet in height. Stripping, mining, and loading are done by Bucyrus diesel loader; trucks haul the clay to the plant. Section of the pit face is about as follows: 50 feet unconsolidated, disintegrated, granitic material overlying 3 feet of pink clay (roofing and hollow tile); 3 feet micaceous clay (waste); 15 feet pink clay (roofing and hollow tile); 6 feet bone clay (high refractories); 6 feet red clay (face brick); 15 feet pink clay (refractories); 35 feet yellow clay (sewer pipe).

Half a mile to the west is the second pit, 250 feet in diameter with an 180-foot face. Section is as follows: 70 feet overburden; 30 feet white clay; 6 feet clay and coal; 8 feet bone clay (3 feet good, 5 feet too much iron); 20 feet pink clay; 50 feet green clay (not used now). The clays in this pit dip about 70° NE., although the general dip is approximately 10° SW.

Half a mile farther west is the third pit, 150 feet in diameter by 75 feet high. Section is as follows: 50 feet overburden; 4 feet brown clay (highly refractory); below this is at least 50 feet of pink clay.

At present 7 men are employed in the quarries shipping 300 tons per day to the plant. They also ship 3 cars of fire clay per day from the



EXPOSURE OF LIGNITE COAL IN CLAY PIT OF ALBERHILL
COAL AND CLAY COMPANY, RIVERSIDE COUNTY

Reprinted from Division of Mines Report XIX, p. 200



RED TOP CLAY DEPOSIT, MECCA HILLS, 6 MILES
NORTH OF MECCA, RIVERSIDE COUNTY

main pit to the Kaiser steel plant at Fontana, for which purpose 3 men are employed by the steel company.

The plant is from half to three-quarters of a mile north of the pits and contains the following principal equipment: TelSmith gyratory crusher, 7 American 9-foot drying pans, one-quarter, 18-mesh screens, fire brick dry press, double pug mill, stiff mud brick machine, 2 rough tile machines, one hollow tile and brick machine, steam sewer pipe press, 64 tunnel driers, sewer pipe drying floor, 18 beehive kilns, 30 feet inside diameter, one gas-fired Harrup tunnel kiln.

Tunnel and beehive kilns are operated at 2462° F. on fire brick; on sewer pipe at 2129° F. Beehive kilns have a capacity of 6000 feet of 4-inch sewer pipe or 60,000 brick, tunnel kiln, 30,000 fire brick. Tunnel kiln operates on 72-hour cycle, giving daily capacity of 10,000 brick, beehive kilns 6 days burning, 5 to 6 days drying, daily capacity about 5500 brick per kiln. Total capacity is approximately 110,000 brick per day.

Clays found on the property deform at temperatures ranging from cone 4 to cone 33. A little barium carbonate is added at the plant to promote red color on the ware when burned.

Normally 180 men are employed. They now have only 80 but could use a full crew if available.

Bibl.: State Mineralogist's Report XXV, p. 501; Bull. 38, p. 223; Bull. 99, pp. 174-176.

Middlesworth Clay Deposit. This deposit comprises four 20-acre placer claims, known as Brown Star claims, in the Cleveland National Forest Reserve, in the NW $\frac{1}{4}$ sec. 14, T. 4 S., R. 7 W., S. B., 4 $\frac{1}{2}$ miles south of Corona; elevation 2100 feet. Owner is J. C. Middlesworth, Corona, California.

The bed of pottery clay, reported to be 20 to 30 feet thick, strikes northwest, dips 12 to 15° SW. It is overlain by 20 to 30 feet of overburden, with a bed of impure bauxite 2 to 6 feet in thickness. In 1944, Kaiser Company, Inc. did considerable development work on the bauxite strata running a number of cuts with bulldozer equipment to determine the extent of the bauxite. Northwest of Gypsum Canyon, along the same general strike, is a bed of blue fire clay reported to be 20 feet thick with 10 to 20 feet of overburden. Development consists of two tunnels, 150 feet in length. Idle.

Morton clay deposit, comprising 80 acres, is in secs. 30 and 31, T. 5 S., R. 4 W., 2 $\frac{1}{2}$ miles north of Elsinore. Owners are Geo. H. Morton and son, Elsinore, California.

The soil and red clay overburden, 15 to 25 feet thick, rest on blue plastic clay which varies in thickness from 15 to 25 feet. The clays dip about 15° W.

Two shovel cuts each approximately 200 feet long by 30 feet deep have been made in the deposit. Apparently the property has long been idle.

Bibl.: State Mineralogist's Report XXV, p. 501.

Pacific Clay Products Company, Roy Lacy, president, A. T. Wintergill, vice president and general manager, 306 West Avenue 26, Los Angeles, owns and operates two pits and has leased a small area from the Alberhill Coal & Clay Company from which they are also shipping clay.

The Murphy pit is in the NW $\frac{1}{4}$ sec. 35, T. 4 S., R. 6 W., on a small knoll about 300 feet north of the Santa Fe Railroad tracks. It is a side-hill cut with a face 200 feet long by 50 feet high. Under some 20 feet of overburden there is about 30 feet of red and yellowish-brown clay.

The South pit is in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 4 S., R. 6 W., S. B. It is a side-hill cut 250 feet long by 30 feet high; overburden 10 to 15 feet; white siliceous fire clay 12 to 18 feet; red, taley sewer-pipe clay 15 feet.

This company is also shipping from the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 5 S., R. 5 W., where it has leased 300 feet by 800 feet from Alberhill Coal & Clay Company. The clay is shipped to the company's several plants in the Whittier and Los Angeles areas.

Three men were working on the leased ground.

Palen Mountains Clay Deposit. This deposit comprises six 160-acre placer claims, known as Eureka group, situated in Clay Hills, 2 miles south of the Palen Mountains in sec. 28, T. 5 S., R. 18 E., S. B., 31 miles northwest of Blythe. Owners are Louis Favret and associates, Blythe, California. Elevation is 1500 feet.

Small, rounded, clay hills extend for a distance of several miles in an easterly direction. The belt is about 1 mile in width and 2 miles in length. The clay is an impure bentonite, high in lime, associated with volcanic ash. It is undeveloped.

Red Top Clay Deposit. This deposit is situated in the Mecca Hills, comprising 640 acres of patented land in sec. 21 and three 160-acre placer claims located in sec. 20, T. 6 S., R. 9 E., S. B., 6 miles north of Mecca; elevation 300 to 600 feet. Owner is Louis Schirm, Los Angeles.

The Tertiary beds of the Mecca Hills consist of soft, poorly consolidated conglomerate, sand, and clay, containing in places small amounts of gypsum and some other saline materials. Beds of sand of varying fineness and of clay make up the larger part of the Tertiary strata in the Mecca Hills. The estimated thickness of the Tertiary beds in the Mecca Hills is from 4000 to 5000 feet. The belt of Tertiary clay on the Red Top claims is 1 $\frac{1}{2}$ miles in length and about 2000 feet in thickness and lies between two belts of sandstone and conglomerate. The clay is gray to brown in color, intermixed with gypsum and potash and soda salts in minor quantities. Development consists of tunnels and open cuts. Idle.

Temescal Clay Company, L. H. Maddux, 423 Ramona Street, Corona, California, has under lease the Harrington pit. This pit belongs to the Harrington estate. It is in sec. 35, T. 4 S., R. 6 W., S. B.

This pit is a semicircular side-hill cut, about 700 feet in diameter and approximately 140 feet in height. The clays here dip flatly to the northeast. Section as exposed in this cut is as follows: overburden 60 feet; bone clay 6 feet; pink mottle clay 10 feet; red mottle clay 20 feet; gray clay 3 to 6 feet; red clay 40 feet.

Clay is loaded by 1 $\frac{1}{4}$ -yard and $\frac{3}{4}$ -yard Lorraine shovels. Thirty to 35 cars per month are shipped to Gladding McBean & Company and Pacific Clay Products Company. Three men are employed.

Bibl.: Bull. 99, p. 181; State Mineralogist's Report XXV, p. 502.

Feldspar, Silicia, and Glass Sand

In the past large quantities of feldspar and silica quartz were mined in Riverside County. The principal localities were Lakeview, Nuevo, Winchester, and Murrietta. In the last few years this industry has ceased to exist in these areas.

The deposits are fully described in our Reports of the State Mineralogist XXV, pp. 502-507; XXVII, pp. 442-445.

Brown Silica Deposit. This deposit comprises one claim situated on the east slope of Cottonwood Mountains, in sec. 3, T. 5 S., R. 11 E., S. B., 3 miles north of Cottonwood Springs and 10 miles northwest of Shavers Summit, on U. S. Highway 60; elevation 3100 feet. Owner is E. M. Brown, Los Angeles.

A massive outcrop of quartz occurs in granite. It is about 300 feet in length by 20 feet in width; developed by open cut 100 feet in length by 200 feet in depth. In 1935, 300 tons of silica was shipped to Gladding McBean Company, Los Angeles. The silica shipped was reported to be 98.6 percent SiO_2 , free of iron. Idle.

Jones deposit is on the old Hoag Ranch 7 miles southeast of Corona, in secs. 17 and 19, T. 4 S., R. 6 W., S. B. Owner is A. E. Jones, Corona, California.

The deposit forms a chain of four low hills. The axis of these hills has a general easterly trend and they rise approximately 150 feet above the bottom of the canyon. Their tops are only a few feet across, while at the base the thickness is about 250 feet. The total length is 1200 to 1500 feet. These hills appear to be entirely composed of unconsolidated sand, consisting of rounded grains, with practically no visible impurities. The overburden consists of $1\frac{1}{2}$ to 4 feet of sandy soil. The deposit dips to the southeast at an angle which is estimated to be about 20° . It is reported that the raw material is composed of 97.45 percent silica and 97.54 percent after it is washed and screened; also that the iron content ranges from 0.09 percent to 0.11 percent. There is very little mica. Idle.

Bibl.: State Mineralogist's Report XXV, p. 505.

P. J. Weisel, Industrial Sand, P. O. Box 295, Corona, California, G. A. Van Valin, manager, has 150 acres in sec. 21 ?, T. 4 S., R. 6 W., which is a part of an 800-acre tract, 6 miles southeast of Corona. Owner is P. J. Weisel.

The deposit is a very compact bed of sand the full extent and thickness of which are not exposed. Present quarry is practically on the Corona-Elsinore highway, on the northeast side. It will also be opened on the southwest side of the highway, where a large tonnage is known to exist.

The present pit is 600 feet long, 600 feet wide; the face is 120 feet high. The overburden of gravel, clay, and sand varies from nothing to 20 feet thick. The face is drilled with 90-foot churn drill holes, with 14-foot lifters at the bottom. These are blasted with 40 percent powder; average about 10,000 tons per shot, 12 to 14 tons per pound of powder. The sand contains 3 percent Al_2O_3 (aluminium oxide) and they try to clean it down to 0.05 percent iron, 0.07 percent being the maximum allowable.

The plant is at the north end of the pit. Material is moved from the face by dragline 1200 feet long, to grizzly, 16-inch belt conveyor, 200 feet long, to bin, screw conveyor to 4-foot by 20-foot trommel, $\frac{1}{2}$ -inch round holes, oversize to waste, 25 percent screenings to 2 drag classifiers, overflow to tails, sands to double deck screen 8 and 20-mesh minus 8, plus 20 to sand blast bins; plus 8 and minus 20 to two 6-foot by 19-foot pebble mills and 8-foot by 36-inch Hardinge mill, one pass, minus 24 mesh product to 2 screw classifiers, for washing, to 2 drag classifiers also for washing, to concrete slab for draining, to rotary, natural gas fired dryer, 5 feet by 24 feet, temperatures up to 500° F., elevator to double Hummer screen 24 and 30 mesh, minus 24, plus 30 glass sand to Stearns magnetic separator. This product is also used for stucco plaster. They produce about 3000 tons per month and ship by Santa Fe Railroad. About 10 men are employed.

Bibl.: State Mineralogist's Report XXV, p. 504.

Fluorspar

Fluorspar Group of Mines. This group comprises 5 claims situated on the north end of Palen Mountains, one mile southwest of Packard's Well, in sec. 4, T. 3 S., R. 18 E., S. B., 18 miles northwest of Midland. Owners are Louis Favret, L. H. Raines, Blythe, California and N. A. Anderson, Pasadena, California.

The county rock is monzonite. The vein strikes N. 65° E. and dips 45° N.; width 5 feet. Fluorspar occurs in bunches and as a dissemination in the gangue, intimately associated with the copper minerals malachite and azurite.

Development consists of open cut 100 feet in length, 5 feet deep and 5 feet wide. The fluorspar is white, green, and purple in color. Idle.

Bibl.: State Mineralogist's Reports XV, p. 556; XXV, p. 470; Bull. 50, p. 543.

Red Bluff Fluorspar Deposit. This deposit comprises 8 claims located as Red Bluff No. 1 to No. 7, and Lucky Day, situated on the east slope of the Little Maria Mountains, in sec. 27, T. 3 S., R. 20 E., S. B., 14 miles south of Rice, a station on the Santa Fe Railroad; elevation 1800 feet. Owners are Tom Ashby, Rice, California, and P. D. McIntyre, Louis Favret, B. H. Raines, of Blythe, California; under lease and bond to N. A. Anderson, Pasadena, California and Roy Cornell, Los Angeles.

A series of roughly parallel veins of fluorspar occurs in quartzite and mica schist; strike N. 50° W., dip 75° N., width 18 inches to 3 feet. Development on the Red Bluff vein consists of a shaft sunk to a depth of 30 feet. This shaft developed a lens of fluorspar about 40 feet in length and 2 to 4 feet in width. To the northwest of these workings there is a trench 50 feet in length which exposes 12 to 18 inches of fluorspar. At a higher elevation, a shaft has been sunk to a depth of 30 feet on a vein which strikes N. 30° W., dips 70° E. Width of vein is 2 to 4 feet. At this point there is also a vein that strikes N. 50° W. During 1944, one hundred and thirty tons of fluorspar was mined and shipped to the National Supply Company, Torrance, California; analysis 87 percent CaF_2 , 4 percent SiO_2 , 0.47 percent CaO , 2.25 percent Al_2O_3 , 0.15 percent Fe_2O_3 . A headframe has been installed at the shaft and it is planned to sink a shaft to a depth of 100 feet and resume shipments of ore.

Equipment consists of tugger hoist and 90-cubic foot compressor. Three men are employed.



RED BLUFF FLUORSPAR DEPOSIT, LITTLE MARIA
MOUNTAINS, 14 MILES SOUTH OF RICE,
RIVERSIDE COUNTY

Gems

Gem minerals occur in Riverside County in the San Jacinto Mountains in the Coahuila district on the east end of Thomas Mountain and on the north end of Coahuila Mountain. The gem minerals are found in pegmatite dikes that occur in granitic rocks. The gems produced were black, pink, and green tourmaline, beryl, aquamarine, rose quartz, and quartz crystal. The principal production was from the gem mines known as California, Columbia, and San Jacinto on Thomas Mountain, and from the Fano and Schindler mines on Coahuila Mountain. The most recent production has been from the Beryl-Crystal group of claims owned by Charles Schindler, of Los Angeles. The gem minerals produced from these claims were aquamarine, beryl, black, pink and green tourmaline, rose quartz, quartz crystal, and topaz.

Fano Mine. This Fano mine comprises 2 patented claims, 37 acres, situated on the north slope of Coahuila Mountain, in secs. 32 and 33, T. 6 S., R. 2 E., S. B., 5 miles northwest of Coahuila and 14 miles southeast of Hemet; elevation 4500 feet. Owners are Clark and Campbell, Coahuila, California. The property was formerly owned and operated by the Fano Kunzite-Tourmaline Mining Company.

The pegmatite dike strikes northwest and dips 20° southwest; it is 6 to 8 feet in width. The gem minerals produced from the pegmatite dike were kunzite, beryl, black, pink, and green tourmaline, and rose quartz. Development consists of open cuts and shallow shafts along the strike of the dike. Idle.

Bibl.: Bull. 37, pp. 58-59, 121-122; State Mineralogist's Reports XV, p. 576; XXV, pp. 507-508

Schindler Mine. This mine comprises 4 claims located as Beryl-Crystal and Silica-Beryl mines situated on the north slope of Coahuila Mountain, in secs. 29 and 33, T. 6 S., R. 2 E., S. B., 5 miles northwest of Coahuila and 14 miles southeast of Hemet; elevation 4000 to 4500 feet. Owner is Charles Schindler, Los Angeles. Two claims located as the Beryl-Crystal claims adjoin the Fano mine on the south and are in sec. 33, T. 6 S., R. 2 E.

A massive pegmatite dike occurs in granite, has a general northwest strike, and dips 40° SW. The pegmatite dike is 8 to 10 feet in width. Development consists of a number of open cuts along the strike of the dike for a considerable distance. The open cuts vary from 10 to 20 feet in depth. The gem minerals mined on the Beryl-Crystal claims are black, pink, and green tourmaline and beryl. D. Jerome Fisher of the U. S. Geological Survey reported the occurrence of radiating columbite crystals up to two inches long in albite-quartz rock.

On the Silica-Beryl group of claims situated at a lower elevation and about a mile to the north in sec. 29, T. 6 S., R. 2 E., there is a pegmatite dike about 20 feet in width which strikes northwest and dips 50° SW. The gem minerals mined from these claims were beryl, rose quartz, and quartz crystal.

It is reported that 200 pounds of beryl, 10 pounds of pink and green tourmaline, 50 pounds of black tourmaline, 500 pounds of quartz crystals and 100 pounds of rose quartz have been produced from this property.

Property is idle due to World War II.

Granite

The several granite quarries in Riverside County have supplied the greater part of the rock used in breakwater and dam construction, rip-rap work, and monumental stone in southern California.

Blue Gray Granite Quarry in sec. 32, T. 3 S., R. 4 W., S. B., $3\frac{1}{2}$ miles west of Val Verde was formerly operated by E. Johnson, Perris, California, who produced monumental stone. The property is owned by N. B. Walters, 28 South Chapel Street, Alhambra, California.

Idle.

Bibl.: State Mineralogist's Report XXV, p. 508.

Bly Bros. and McGilliard Company, of Los Angeles, formerly operated a quarry in sec. 1, T. 2 S., R. 6 W., at the foot of the west slope of Jurupa Mountains, 5 miles west of Riverside. Idle.

Bibl.: State Mineralogist's Reports XV, p. 585; XXV, p. 508.

Corona Rock Company formerly operated a quarry in secs. 8 and 17, T. 3 S., R. 6 W., S. B.; also at Porphyry Station.

Bibl.: State Mineralogist's Report XV, p. 585.

Ormand quarry is in sec. 9, T. 2 S., R. 5 W., on the Rubidoux Ranch, 3 miles west of Riverside, in the Jurupa Mountains. It has been under lease for the past year to Guy F. Atkinson Company. This company has quarried and used the rock for construction of a breakwater for the navy at Seal Beach.

The quarry rock is a gray, compact granodiorite which breaks in large pieces, making it desirable in the type of construction for which it is used. It was used in the Long Beach Harbor breakwater, some of the dams of the Metropolitan Water District aqueduct, and other similar types of structures. The present contract called for 700,000 tons and is now nearly finished (January 1945).

The present quarry face is 2000 feet long by 290 feet high. It is drilled with 9-inch churn drill holes, 15 feet apart, 40 feet back from the face. The holes are put down to the quarry floor. After springing they are blasted with 60 percent dynamite. Such a shot along the entire face would break approximately 1,500,000 tons. Material is loaded into cars by one steam and two electric shovels. Three locomotives are used for switching and spotting cars. At the height of the present operation 6000 tons per day were shipped, and 130 men were employed. At present 2000 tons, in pieces of 2 tons to 10 tons each, are shipped. Thirty men are employed.

Bibl.: State Mineralogist's Report XXV, p. 509; The Explosives Engineer, Oct. 1929.

Temecula Quarries. Two quarries which are 2 miles south of Temecula were operated by various persons for many years but have now long been idle.

Bibl.: State Mineralogist's Report XV, p. 586.

Temescal Rock Quarry. This quarry is on a 200-acre tract in sec. 4, T. 4 S., R. 6 W., S. B., in Temescal Canyon about 4 miles southeast of Corona; elevation 1000 to 1200 feet. Owner is Blue Diamond Materials Company, Los Angeles.

The deposit, consisting of rhyolite porphyry, has been quarried from a steep mountain side. The rock is hard and when crushed is very sharp. The larger pieces, up to 10 tons, have been used for rip-rap and sea-wall construction.

Four miles of railroad formerly built to the property have been removed. Bins having a capacity of 2000 tons per day were destroyed by fire in 1927. It is reported that the quarry is to be reopened.

Bibl.: State Mineralogist's Reports XV, pp. 586-587; XXV, p. 524.

Gypsum

This material, the hydrous calcium sulphate (CaSO_4) $2 \text{ H}_2\text{O}$, is of much importance in construction and building products, since the calcined product, plaster of paris, is the base of nearly all wall plasters for interior work and also for the manufacture of wall board. It also forms the base of a material known as staff which is extensively used in the construction of temporary buildings for exposition purposes. During the second world war, there has been an increased demand for wall board and plaster in the construction of houses and barracks at army and navy training bases throughout the United States and especially for army camps in the desert areas of California.

Gypsum is also important as a soil conditioner in supplying lime and correcting alkaline soils and is sold as land plaster. In small quantities, it is used in the manufacture of Portland cement to retard setting.

Gypsum occurs in a number of small areas in the Cleveland National Forest Reserve between Eagle and Hagador Canyons in a belt that strikes northwest for a distance of $2\frac{1}{2}$ miles in T. 4 S., R. 7 W., S. B., 4 miles south of Corona. These gypsum deposits are low grade, varying from 15 to 38 percent gypsum. This material has been used for a number of years as a soil conditioner by the citrus growers in Riverside County.

Extensive deposits of gypsum occur in Little Maria Mountains, Maria Mountains, Palen Mountains, and the Riverside Mountains, in the northeastern desert section of the county. The principal production at present is from deposits owned and operated by the U. S. Gypsum Company in the Little Maria and Maria Mountains near Midland. The belt here is approximately $2\frac{1}{2}$ miles long, about $2\frac{3}{4}$ miles wide at the east end and 1 mile wide at the west end. It has an easterly strike and a variable dip to the north. The gypsum is very pure and the beds in places are several hundred feet in thickness. It is finely crystalline and the color varies from transparent white to slightly reddish. Deposits occur in the northern end of the Palen Mountains, south of Adams Well. The gypsum occurs interbedded with limestone; beds strike eastward and dip 40° S.

In the Riverside Mountains are two large deposits of high-grade gypsum, but due to inaccessibility these deposits have not been developed. The gypsum occurs as massive beds interbedded with limestone. The beds are 50 feet thick and extend for a distance of 700 feet. One deposit is in sec. 7, T. 2 S., R. 24 E., S. B., $7\frac{1}{2}$ miles south of Vidal, in the Colorado Indian Reservation; the other, the more extensive deposit, lies to the north in sec. 6, T. 2 S., R. 24 E., S. B., and is outside of the Indian reservation.

Frazer Gypsum Deposit. This deposit comprises 70 acres situated in Eagle Canyon in the Cleveland National Forest Reserve, in the W $\frac{1}{2}$ sec. 24 and the SW $\frac{1}{4}$ sec. 13, T. 4 S., R. 7 W., S. B., 4 $\frac{1}{2}$ miles south of Corona; elevation 1600 feet. Owner is T. A. Frazer, Corona, California; under lease to Dr. Levi Katz, Glendale, California.

The belt of gypsum occurs on the ridge between Eagle Canyon and Manning Canyon, in the SW $\frac{1}{4}$ sec. 13. It strikes N. 70° W. and dips 40° N. and can be traced along its outcrop for a distance of 1500 feet. The gypsum content ranges from 15 to 25 percent, and is associated with iron and lime. Development consists of a tunnel driven southeast 20 feet and an open cut 60 feet in length and 15 feet in depth on the east side of Eagle Canyon. On the west side of Eagle Canyon, a tunnel is driven west 80 feet; about 200 feet south of this tunnel there is an open cut 70 feet in length. On the west side of Manning Canyon on the same belt, a tunnel has been driven west 100 feet.

Dr. Katz and Floyd Shoemaker, of Glendale, California, installed a small crushing plant on the east side of Eagle Canyon which consisted of Williams hammer mill, with bucket elevator to 10-ton storage bin. Ore mined from open cut was delivered to crusher. Two hundred tons of material are reported to have been shipped in the latter part of 1944. Due to high moisture content, operations were suspended and it is now planned to install a dryer. Idle.

Bibl.: State Mineralogist's Report XV, p. 579.

Gypsum Canyon Gypsum Deposit. This deposit comprises 40 acres on the ridge northeast of Gypsum Canyon in the S $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 15, T. 4 S., R. 7 W., S. B., 4 $\frac{1}{2}$ miles south of Corona; elevation 2000 feet. Owner is J. C. Middlesworth, Corona, California; under lease to Victor Mishelle, West Los Angeles, California.

The gypsum beds occur in Jurassic meta-volcanic rocks and where exposed are 700 feet in width and 300 feet in height above the canyon. The deposit has been developed by tunnels and open cuts. Analysis of samples taken in tunnel, made by Ed Eisenhauer, Jr., Los Angeles, is as follows:

	Percent
Calcium oxide (CaO)	11.05
Magnesium oxide (MgO)	.81
Ferric oxide (Fe ₂ O ₃)	5.32
Aluminum oxide (Al ₂ O ₃)	4.43
Sodium oxide (Na ₂ O ₃)	1.13
Potassium oxide (K ₂ O ₃)	0.17
Sulphuric anhydride (SO ₃)	16.31
Loss in ignition	13.35
Gypsum (CaSO ₄) 2 H ₂ O	31.24

This material would be a good soil conditioner because of its gypsum, iron, and lime content. The deposit was formerly worked in 1914-1915 by George W. Lord, Corona, California. The material was used by the citrus growers in the vicinity of Corona.

Bibl.: State Mineralogist's Report XV, p. 579.

Hagador Canyon Gypsum Deposit. The deposits of gypsum are situated on a ridge northwest of Hagador Canyon and comprise five 20-acre placer claims known as Big Chief No. 1, Big Chief No. 2, Amador, and Morning Star No. 1 and No. 2, situated in the NW $\frac{1}{4}$ sec. 15, T. 4 S.,

R. 7 W., S. B., 4 miles south of Corona; elevation 2000 feet. Owners are J. C. Middlesworth and G. E. McCorkill, Corona, California; under lease to Victor Mishelle, West Los Angeles, California.

The gypsum beds strike east, dip 70° N. Width of exposure is from 200 to 300 feet, with a length of 750 feet. The principal outcrop is on Big Chief No. 2 claim and is about 600 feet in elevation above the canyon. Development consists of shallow open cuts and a tunnel 20 feet in length on Big Chief No. 1 claim.

On Morning Star No. 1 and No. 2 claims on the west side of Hagador Canyon is an exposure of clay containing 25 to 37 percent gypsum. The zone is about 600 feet in width and 1500 feet in length. Strike is N. 70° W., dip 60° S. About 600 feet in elevation above the canyon is an open cut 75 feet in width and 15 feet in height. In 1910, 275 tons of material was mined and shipped to citrus groves near Corona for a soil conditioner.

On the Amador claim, located south of Big Chief No. 1 and No. 2 claims, about 1800 feet north of canyon, there is an outcrop of gypsum several hundred feet thick which occurs in meta-volcanic rocks. This deposit was worked from 1927 to 1934 by E. R. Nonhoff, Corona, California, and considerable tonnage was sold to citrus growers in Riverside County as a soil conditioner. Formerly Nonhoff operated a crushing and screening plant with a reported capacity of 40 tons per day. Material from open cut was delivered by jig-back tram 1800 feet in length.

The deposit was formerly owned by Amestoy Estate of Los Angeles, California; relocated by present owners in 1941.

Analysis of samples by Smith-Emery Co.:

	Percent
Big Chief No. 1—Calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)	14.7
Phosphoric anhydride (P_2O_5)	0.05
Big Chief No. 2—Calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)	18.5
Phosphoric anhydride (P_2O_5)	0.06

Samples were taken from Big Chief No. 1 and No. 2 outcrops and submitted to Ed Eisenhauer, Jr., of Los Angeles, for analysis:

	Percent
Calcium oxide (CaO)	8.80
Magnesium oxide (MgO)	0.62
Ferric oxide (Fe_2O_3)	4.19
Aluminum oxide (Al_2O_3)	3.66
Sodium oxide (Na_2O)	2.89
Potassium oxide (K_2O)	0.30
Sulphuric anhydride (SO_3)	12.06
Loss in ignition	13.07
Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) (calculated)	23.05

This material would be suitable for soil conditioner, because of the gypsum associated with iron and lime. To be of commercial value the gypsum content should be in excess of 20 percent. Therefore, in working this class of deposit, a certain amount of selective mining would be required. Idle.

Bibl.: State Mineralogist's Report XV, p. 579; Bulls. 101 and 111.

Palen Mountains Gypsum Deposit. This deposit comprises 1600 acres in the north end of Palen Mountains in secs. 2, 3, 4, 9, 10, 11, T. 3 S., R. 18 E., S. B., about a mile south of Adams Well and 24 miles north-

east of Blythe; elevation 1600 feet. Owners are John Webb, Vista, California, and George Pepperdine, Los Angeles.

The gypsum occurs irregularly in a belt two miles in length and about a mile in width. The strata of gypsum occur in limestone near its contact with granite. The strike is east, dip 40° S.; width 8 to 10 feet, length 300 feet. Development consists of open cuts and short tunnels.

Bibl.: State Mineralogist's Report XXV, p. 510.

Parkford Gypsum Deposit. This deposit is situated on the east slope of the Riverside Mountains in the NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 2 S., R. 24 E., S. B., 7 $\frac{1}{2}$ miles south of Vidal; elevation 700 feet. Owner is Colorado Indian Reservation, C. H. Ansler, superintendent, Parker, Arizona.

The main deposit of gypsum forms a low hill about 250 feet high, and 400 feet wide. The gypsum hill consists of massive beds of gypsum interbedded with limestone. The beds are 50 feet thick and extend for a distance of 700 feet. Southeast of this ridge, the beds appear in three hogbacks extending for a distance of 600 feet and containing three beds of gypsum aggregating 70 feet in thickness. The beds strike north, dip west at angles of 30 to 60° . The gypsum is white in color and reported to average 98 percent. It is estimated the deposit contains about 2,000,000 tons. Development consists of open cuts and five tunnels from 20 to 200 feet in length. Idle.

Bibl.: State Mineralogist's Report XXV, p. 511.

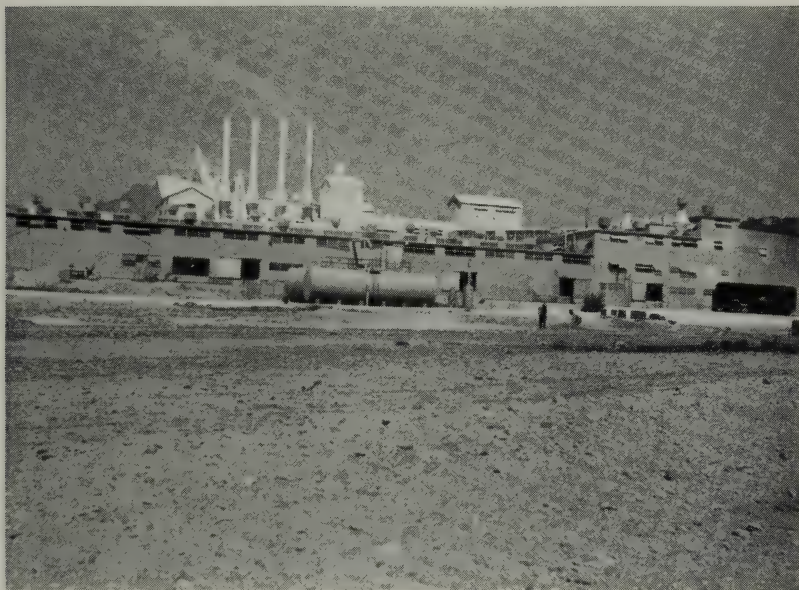
Riverside Mountains Gypsum Deposit. A large deposit of gypsum occurs on the east slope of the Riverside Mountains, one mile northwest of the Parkford deposit in sec. 6, T. 2 S., R. 24 E., S. B., 7 $\frac{1}{2}$ miles south of Vidal; elevation 800 feet. Owners are Rodney Turner and associates, Los Angeles; located 3 placer claims, 480 acres.

The gypsum beds have an average thickness of 70 feet and can be traced along the outcrop for at least 1000 feet in length. Samples taken along the outcrop are reported to average 98 percent. Engineers estimate that the deposit contains 10,000,000 tons of commercial grade gypsum. Road is being built to the deposit.

United States Gypsum Company, Chicago, Illinois. Local office is at 816 West Fifth Street, Los Angeles; plant and mine office at Midland, California; R. W. Thomas, works manager, J. F. Havard, general manager.

The deposits of gypsum being worked by this company are situated in Ironwood mining district, on the east slope of Little Maria Mountains and on the west slope of Maria Mountains, in secs. 5, 6, 7, 8, T. 4 S., R. 21 E. and secs. 1, 2, 3, 10, 11, 12, T. 4 S., R. 20 E., and in secs. 35 and 36, T. 3 S., R. 20 E.; also in secs. 18 and 12, T. 4 S., R. 22 E., S. B. at Midland and 23 miles northwest of Blythe; elevation 1150 feet. Since the Twenty-fifth Report of the State Mineralogist was published, which contained a description of this company's properties, the company has acquired the Garland, Garbutt and Orcutt, Langdon, and Savage deposits. These are also described in the Twenty-fifth Report, pages 510-513. The plant and town are located at Midland, a station on the Santa Fe Railroad. The gypsum being mined at present is from the Little Maria Mountains 2 $\frac{1}{2}$ miles west of Midland.

Gypsum occurs interbedded with limestone and amphibolite schist. The strike of the gypsum beds varies from east to northeast. Dips vary



U. S. GYPSUM COMPANY PLANT AT MIDLAND, RIVERSIDE COUNTY



RIVERSIDE CEMENT COMPANY PLANT AT CRESTMORE, RIVERSIDE COUNTY

from 20 to 35° N. and NW. On the west is a bed of limestone some 200 feet in thickness. Beyond this are schists and intrusive rocks. To the east is an amphibolite schist several hundred feet, which contains considerable quartz. The schist is succeeded by beds of limestone and gypsum. This whole series is faulted, the northern portion having been moved 60 feet to the east. Another similar fault occurs five-eighths of a mile to the south. In the gypsum beds being mined, isolated bunches and continuous strata of anhydrite are encountered. These may be found at almost any horizon in the deposits, due to intense folding. The gypsum is white, crystalline, compact, and uniform in grade, said to average 94 percent gypsum. The lenses being worked at present are approximately 2000 feet in length and 20 to 60 feet thick. The gypsum mined comes from the Brown mine. The workings consist of a pit 500 feet long, 50 feet wide, and 50 feet deep. Here, the gypsum bed strikes north and dips 75° W. At the entrance of open pit, a shaft is sunk to a depth of 80 feet. At the bottom of the open cut, there are two tunnels driven in a southwesterly direction, each about 200 feet in length. The ore mined from the tunnels and open cut is hauled over narrow gauge track by gasoline-driven motor in a train of six cars, with a capacity of 3 tons per car, to crusher at plant, a distance of one mile. To the southwest of the Brown mine are two tunnels driven southwest on veins known as No. 4 and No. 6, separated by a stratum of limestone. The beds are from 20 to 60 feet in thickness. The lower tunnel runs west a quarter of a mile, then turns southwest and follows along the footwall of No. 6 vein for three-quarters of a mile, then a crosscut is driven north to No. 4 vein which is parallel and overlies No. 6 vein. Stopes are made on No. 6 vein to the surface, at 25-foot centers. The approximate distance to surface from haulage tunnel on No. 6 vein is about 400 feet. Pillars, which will be removed at some future date, are left between stopes. Gypsum mined in stopes is removed by Sullivan slushers and loaded direct into cars and trammed by mule to entrance of tunnel where it is dumped into loading bins below tunnel level. From loading bins, it is hauled by trucks, 8-ton capacity, to plant a distance of 2½ miles. The total underground workings on No. 4 and No. 6 veins are over a mile in length. Gypsum is also being mined from two open cuts about a mile southeast of No. 6 workings. The bed of gypsum exposed in open cut is from 60 to 150 feet thick and about 700 feet in length. It strikes east and the dip ranges from 20 to 35° N. About one-quarter of a mile north of this open cut is another open cut which is being developed on a bed of gypsum 60 feet thick. The ore mined from open cuts is loaded by Southwest steam shovels into trucks having a capacity of 12 tons and hauled to crusher at plant, a distance of two miles. Since the last written report on the gypsum plant, the capacity has been increased from 300 tons to 800 tons per day. The present operating capacity is 600 tons per day, due to the shortage of man-power. The ore from the Brown mine, opencuts and tunnel No. 6 workings goes to Williams hammer mill; crushed and elevated to three 600-ton circular silos; from silos to four Raymond mills for fine grinding, from Raymond mills, the ground product goes to three calcining kettles, heated to 360°. In calcining the crude gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), the free water and three-quarters of the crystallized water are expelled to give a final product called stucco ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$). The calcined product from kettles goes to tube mill, ground to minus 325 mesh for stucco plaster. From tube mill

ground material is elevated to storage bins, from storage bins to Bates packing machines, to paper sacks, for shipment. Calcined product from three kettles is conveyed to storage bins in wall-board plant where fibre is added to plaster. The capacity of the wall-board plant is 100,000 square feet of $\frac{3}{8}$ -inch wall board and lath. This plant is reported to be the largest wall-board plant in the United States. The power plant consists of two 700-horsepower Fairbanks-Morse diesel engines; one 700-horsepower Winton diesel engine; one 600-horsepower Fairbanks-Morse diesel engine; one 300-horsepower Fairbanks-Morse diesel engine; and one 200-horsepower Fairbanks-Morse diesel engine. The diesel engines are direct-connected to K.V.A. generators. Total horsepower required to operate the plant is 3260. Water to operate plant and camp is delivered in tank cars by the Santa Fe Railroad from Blythe.

The gypsum products produced are wall plaster, finishing and casing plaster, wall board and lath. In the post-war period, agricultural gypsum and retarder for cement plants will be produced. Four hundred men are employed.

Bibl.: State Mineralogist's Report XXV, pp. 513-515.

Limestone

Bautista Canyon Deposits. Two deposits in this canyon $11\frac{1}{2}$ and 12 miles east of Hemet were formerly owned and operated by H. S. Moore, Winchester, California, and San Jacinto Rock Products Company, G. W. Green, president, San Jacinto, California. Idle.

Bibl.: State Mineralogist's Report XXV, p. 516 and pp. 519-520.

Eden Hot Springs deposit is in sec. 23, T. 3 S., R. 2 W., S. B., just east of Eden Hot Springs, on the west slope of San Jacinto Mountains, about 10 miles northwest of San Jacinto. Owner is Thos. D. McTavish, Route 1, Box 82, Camarillo, California.

The belt of limestone strikes northwest, is white in color, coarsely crystalline, and is reported to be 98 percent calcium carbonate. Idle.

Guiberson deposit is in the SE $\frac{1}{4}$ sec. 22 and the SW $\frac{1}{4}$ sec. 23, T. 3 S., R. 3 E., S. B., $1\frac{1}{2}$ miles south of Whitewater. The property consists of 160 acres, patented. Owner is S. A. Guiberson, 1000 Forrest Avenue, Dallas, Texas.

The lenticular limestone deposits here occur between granitic walls. The strike is N. 48° W.; the dip is not fully determined although five drill holes were put down by the Metropolitan Water District of Southern California. These holes were drilled to determine if there was sufficient limestone of suitable grade for the manufacture of cement to be used in construction of the Colorado River Aqueduct. The greatest thickness of limestone encountered was 110 feet and that thickness was not continuous. The project was abandoned.

Bibl.: State Mineralogist's Report XXV, pp. 515-516.

Hubbard limestone is in sec. 23, T. 4 S., R. 1 W., S. B., 4 miles northwest of San Jacinto, just east of the road from Soboba Hot Springs to Gilman's Relief Hot Springs; elevation 2600 feet. Owners are Wm. F. Rohland and Mary Heinsen, Gilman Hot Springs, California.

This deposit is apparently a part of a crystalline limestone bed which intermittently outcrops from this point in a northwesterly direc-

tion to Coyote Pass, a distance of about 8 miles. The deposit strikes N. 40° W., dips to the northeast. About 1000 feet up the canyon north of the road, there is a quarry face about 20 feet high. Material was blasted and allowed to roll down to the bottom of the quarry onto a steel-shell lime kiln. Idle.

Bibl.: State Mineralogist's Report XXV, p. 516.

Magstone Products, Howard Small, 331 Main Street, Riverside, California, has under lease a quarry comprising 17½ acres, owned by Loren Creed, Riverside, California. The quarry is about 3 miles north of Magnolia on Arlington Avenue, in the city of Riverside.

The bed of crystalline limestone strikes northeast, dips about 50° SE. Because of overburden the adjacent rocks cannot be seen; nor can the thickness of the limestone be determined from present exposures. The rock is gray to white and is sold under specifications of not less than 90 percent CaCO_3 nor more than 2 percent MgO .

Present quarry consists of a side-hill cut, approximately 100 feet long and 20 feet high. Material is hauled about 12 miles to the crushing and screening plant at 331 Main Street, Riverside. Present plant has a capacity of 8 tons per day but is to be increased to 40 tons. Product is sold for chicken grit and poultry flour.

One to three men employed.

Novell deposit in sec. 26, T. 3 S., R. 3 E., 2 miles south of White-water, formerly owned by George A. Novell, Monrovia, California, has now reverted to the public domain.

The deposit of blue to gray, coarsely crystalline limestone, strikes N. 40° W., dips 40° SE., is some 100 feet thick and can be traced for about 2500 feet. Idle.

Bibl.: State Mineralogist's Report XXV, pp. 516-517.

Riverside Cement Company, G. A. Beckett, president, W. A. Leonard, vice president and general manager, H. R. Starke, general superintendent, P. S. Peters, mill superintendent, R. H. Wightman, mine superintendent. Main office is at 621 South Hope Street, Los Angeles; plant and quarries at Crestmore, 5 miles northwest of Riverside in secs. 3, 5 and 6, T. 2 S., R. 5 W., S. B.

The blue to white, crystalline limestone is quarried in a butte similar to many which occur in this district, but which usually are composed of granodiorite. The deposit, consisting of two parallel beds, strikes N. 30° W., dips about 50° to 55° E. These beds are separated by some 400 feet of an intrusive granitic rock. The footwall or westernmost body, known as the Stanley bed, is the larger, having a thickness of about 270 feet and a length of some 1500 feet.

In 1925 or 1926, quarry operations having removed most of the limestone above the mill-floor level, development of a mine was begun in the limestone below this level. A vertical 5-compartment shaft was sunk to a depth of 350 feet. This shaft is 300 feet in the footwall of the Stanley bed, at the surface. Levels were driven at 100 feet below the collar (the 800-foot or manway level), 200 feet (the 700-foot or mining level) and 240 feet (the 660-foot or haulage level). Below the 660-foot level is the pump station. The pumping plant has a capacity of 12,500 g.p.m. The pump station is connected with the rest of the mine only through

a concrete-lined raise to the haulage level. An automatic elevator is installed in this raise which is equipped with water-tight doors. Shaft and pump station are lined with concrete.

The development work was planned for the caving of blocks 200 feet long by the width of the deposit, by approximately 200 feet in height. These blocks are isolated by means of cut-off shrinkage stopes at both sides and ends. Drifts on the mining level are driven parallel to the strike of the deposit, on 35-foot centers. On the haulage level below, parallel drifts are driven on 70-foot centers. At 35-foot intervals, a two-branch raise on one side of the drift and a single raise on the other side are driven to connect with the mining-level drifts above. These raises above the mining level are connected and the pillars drilled and blasted allowing the block to settle.

Broken material is loaded from the chutes on the haulage level into 5-ton cars which are drawn in 8-car trains to the 2-car rotary tippie over the main shaft storage pocket by electric locomotives. The 6-ton skips are automatically loaded from the measuring pocket. Skips dump into pocket from which material is fed to 40-inch inclined belt conveyor which transports it to the cement plant some 400 to 500 feet away.

(Detailed description of the mining methods here employed will be found in Information Circular No. 6795 of the U. S. Bureau of Mines, by C. A. Robotham, and Technical Publication No. 1766, American Institute of Mining & Metallurgical Engineers, by R. H. Wightman).

The company also works two surface quarries. One of these is just north and east of the cement plant. This pit is about 900 feet in diameter by 120 feet deep. Here, there are approximately 50 feet of sand, clay, and gravel overburden. Material is loaded by 2½-yard electric shovel into 23-ton trucks, having two steel bodies, each carrying 11½ tons.

Two miles northwest of the plant is the Little Hill quarry. This is a circular pit, 1000 feet in diameter at the top, 200 feet at the bottom, 125 feet deep. There are from 50 to 70 feet of sand and clay overburden. The same equipment is used here as at the plant quarry, and it is moved back and forth as desired.

Plant: Since October 1929 the company has added 2 kilns to its plant, making a total of 14, having a capacity of 10,000 barrels per day.

Bibl.: State Mineralogist's Reports XV, pp. 553-559; XVII, pp. 324-325; XXV, pp. 517-519; and as noted above.

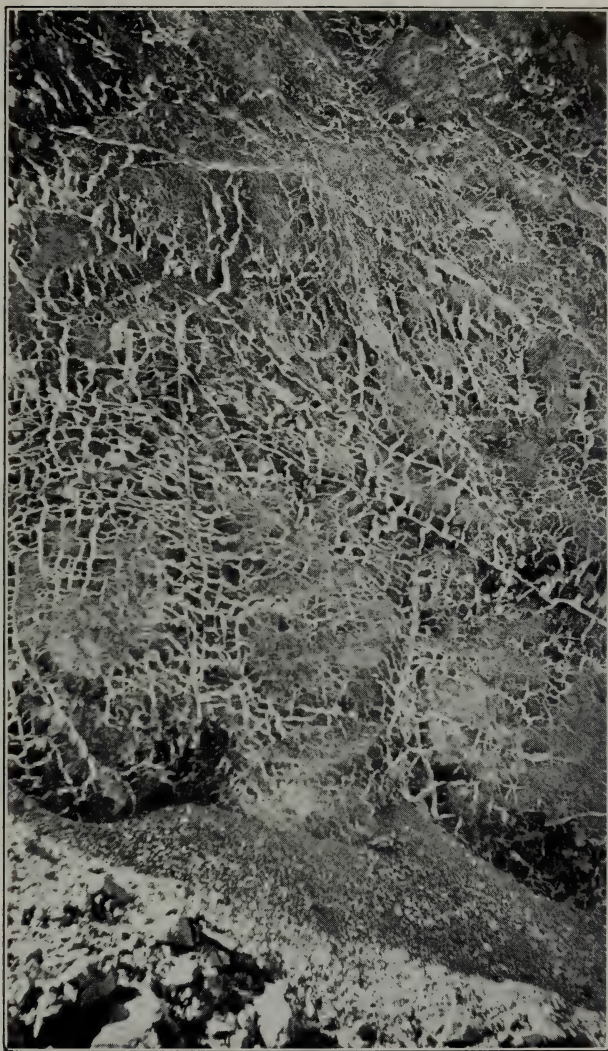
Schellenger deposit about 28 miles north of Blythe in the Maria Mountains; formerly owned by E. E. Schellenger and associates, of Blythe, California; apparently has reverted to the public domain.

It is reported that this deposit is 200 feet thick and that analyses showed its composition to be 98.45 percent calcium carbonate with only 0.25 percent magnesia.

Southern Pacific deposit is in secs. 23 and 25, T. 3 S., R. 3 E., S. B., one mile south of Whitewater; elevation 1500 feet. Owner is Southern Pacific Land Company.

The limestone, from 100 to 200 feet thick, contains numerous intrusions of diorite and strata of mica schist from 8 to 20 feet thick. Undeveloped.

Bibl.: State Mineralogist's Report XXV, p. 521.



STOCKWORK OF MAGNESITE VEINS, HEMET
MAGNESITE DEPOSIT, RIVERSIDE COUNTY

Reprinted from Division of Mines Report XXV, p. 520



BATH HOUSE AT DESERT HOT SPRINGS, 6 MILES
NORTH OF GARNET, RIVERSIDE COUNTY

Magnesite

Hemet Magnesite Mine. The mine is located on the crest of a steep ridge that forms the divide between the valley in which the town of Winchester is situated and Diamond Valley on the south. The mine is 500 feet above the level of the valley. It comprises 160 acres, patented, in the NW $\frac{1}{4}$ sec. 31, T. 5 S., R. 1 W., S. B., 4 miles southeast of Winchester. Owner is Ray Boswell, Los Angeles. The property was operated by Magnesco Refractory Products Company in 1917-1918.

The magnesite occurs in a stockwork of veins in a belt of serpentine 200 to 400 feet wide that is intrusive into micaceous gneiss and schist. The general course of the serpentine is northwest. The deposit was developed by a large open cut 250 feet long by 70 feet wide and 240 feet deep. Idle.

Bibl.: State Mineralogist's Reports XV, p. 579; XVII, pp. 327-328; XXV, p. 521; Bull. 79, pp. 61-65; U. S. Geol. Survey Bull. 355, pp. 38-39; U. S. Geol. Survey Bull. 540, pp. 516-519.

Nichols Magnesite Deposit. Magnesite occurs on Nichols Ranch in the valley north of the Hemet magnesite deposit, probably in the same belt of serpentine, in the NW $\frac{1}{4}$ sec. 30, T. 5 S., R. 1 W., S. B., 3 $\frac{1}{2}$ miles east of Winchester. Owner is Fletcher Nichols, Hemet, California.

A shaft sunk to a depth of 50 feet exposes a stockwork of magnesite veins in serpentine. Idle.

Mineral Springs

The mineral springs of Riverside County on account of their curative properties, attract many people to the resorts which are operated in connection with them. Since 1929 several new springs have been developed, such as Desert Hot Springs, north of Palm Springs; Highland Springs near Banning have been developed as an all-year-around resort. Some of the most noted springs are Glen Ivy, Gilman, Elsinore, Murrieta, Palm, and Soboba. Glen Ivy, Elsinore, and Murrieta springs all occur along a fault line in the Temescal Valley.

Along the western base of the San Jacinto range is another fault line which is marked by a number of hot springs. The most noted are Eden Hot Springs, 9 miles northwest of the town of San Jacinto; Gilman Hot Springs, 3 miles north of San Jacinto, and Soboba Hot Springs, 2 $\frac{1}{4}$ miles northeast of San Jacinto. At the eastern base of San Jacinto Mountains is Palm Springs, the best known and most popular resort in Riverside County. Highland Springs, northwest of Banning, and Desert Hot Springs, 12 miles north of Palm Springs, are located along the San Andreas fault.

Desert Hot Springs are situated on the San Andreas fault, on the southwest slope of the Little San Bernardino Mountains, in the E $\frac{1}{2}$ sec. 30, T. 2 S., R. 5 E., S. B., 6 miles northeast of Garnet; elevation 1300 feet. Owner is L. W. Coffee, 257 South Spring Street, Los Angeles; under lease to American Physio-Therapy Association, Dr. Robert Norton, Desert Hot Springs, California.

When sinking a well for water in 1940 along the San Andreas fault, hot water was encountered at a depth of 300 feet; since that date eight wells have been developed with a combined capacity of 1500 gallons of

hot water per minute, varying in temperature from 112 to 116°. The hot mineral water is used for bath house and swimming pool.

Analysis of water from Desert Springs wells

Dissolved solids		Grains per U. S. Gallon
Silica (SiO_2)	-----	0.71
Aluminum oxide (Al_2O_3)	-----	0.13
Iron Oxide (Fe_2O_3)	-----	Trace
Calcium oxide (CaO)	-----	1.33
Magnesium oxide (MgO)	-----	0.03
Sodium oxide (Na_2O)	-----	13.81
Sulphate (SO_4)	-----	23.81
Chlorine (Cl)	-----	5.03
Carbonate	-----	0.17
Bicarbonate	-----	2.14
Total solids	-----	47.70
Total non-volatile solids	-----	45.61
Total hardness as CaCO_3	-----	3.45

Eden Hot Springs. These springs are situated on the western base of San Jacinto Mountains, along the San Jacinto fault, 9 miles northwest of San Jacinto; elevation 1800 feet. Owner is M. Greenberg.

Eight small springs rise within a distance of 300 feet at the base of a steep granite hill. The maximum temperature of the water is about 110° F. It is moderately sulphureted. A Spanish-type hotel, a number of new cottages, and a complete bathhouse and swimming pool have been built during the last few years.

Chemical analysis of water from Eden Hot Springs

	Parts per million	Grains per gallon
Sodium sulphate (Na_2SO_4)	85.2	5.4
Sodium chloride (NaCl)	84.6	5.3
Sodium carbonate (Na_2CO_3)	132.0	7.7
Magnesium carbonate (CaCO_3)	16.1	0.9
Calcium carbonate (CaCO_3)	41.3	2.4
Sesquioxide, iron and aluminum	15.2	0.8
Silica (SiO_2)	26.8	2.0

Bibl.: State Mineralogist's Report XXV, p. 523; U. S. Geol. Survey Water-Supply Paper No. 338, p. 37.

Gilman Hot Springs. These springs were formerly known as Relief Hot Springs, also as San Jacinto Hot Springs. They are situated at the valley's edge, 3 miles north of San Jacinto; elevation 1650 feet. Owner is Gilman Hot Springs, Mrs. Joe Gilman, proprietor and William Gilman, manager.

About a dozen hot springs issue from the granite on the ridge north-east of the valley. The springs are known as White Sulphur Spring, Lithia Spring, Soda Spring and Black Sulphur Spring. The waters are sulphureted and taste distinctly alkaline. The property is equipped with hotel, bungalows, cottages and cabins, and a large garage to store automobiles. Special bath facilities are available, including Roman tub baths, tule mud baths in individual white tile tubs, and large swimming pool. Gilman's is one of the most popular health resorts in southern California.

Chemical analysis of water—White Sulphur Spring

Silica	15	p.p.m.
Calcium	49	p.p.m.
Magnesium	6	p.p.m.
Sodium	167	p.p.m.
Boron	14	p.p.m.
Fluorine	2.8	p.p.m.
Bicarbonate	154	p.p.m.
Chlorine	128	p.p.m.
Sulphate	157	p.p.m.
Phosphate	present	
Tetraborate	50	p.p.m.
Total dissolved solids	660	

Chemical analysis of water—Lithia Spring

Silica	15	p.p.m.
Calcium	60	p.p.m.
Magnesium	7	p.p.m.
Sodium	171	p.p.m.
Boron	16.1	p.p.m.
Fluorine	3	p.p.m.
Bicarbonate	128	p.p.m.
Sulphate	212	p.p.m.
Tetraborate	57	p.p.m.
Total dissolved solids	725	

Chemical analysis of water—Soda Spring

Silica	15	p.p.m.
Calcium	68	p.p.m.
Magnesium	17	p.p.m.
Sodium	113	p.p.m.
Boron	17.7	p.p.m.
Fluorine	3.0	p.p.m.
Bicarbonate	89	p.p.m.
Chloride	192	p.p.m.
Sulphate	50	p.p.m.
Tetraborate	63	p.p.m.
Total dissolved solids	570	

Chemical analysis of water—Black Sulphur Spring

Silica	18	p.p.m.
Calcium	54	p.p.m.
Magnesium	13	p.p.m.
Sodium	229	p.p.m.
Boron	22	p.p.m.
Fluorine	3	p.p.m.
Bicarbonate	71	p.p.m.
Sulphate	251	p.p.m.
Phosphate	present	
Tetraborate	79	p.p.m.
Total dissolved solids	900	

Temperature of Black Sulphur water is 117° F. Analysis indicates that the water highly concentrated, is chiefly primary saline in character and has secondary alkalinity as a prominent property.

Bibl.: State Mineralogist's Report XXV, pp. 521-523; U. S. Geol. Survey Water Supply Paper 335, p. 38.

Glen Ivy Hot Springs are in sec. 10. T. 5 S., R. 6 W., at the base of Santa Ana Mountains, in Temescal Canyon, 10 miles south of Corona; elevation 1800 feet. Owners are Axel Springborg and wife.

This spring and some smaller springs, are on a southeasterly fault from Whittier through Murrieta and Temecula into San Diego County.

The principal spring in Coldwater Canyon issues at the mouth of a ravine from fractured granite and porphyritic rocks. The water is sulphureted and slightly alkaline in taste. The temperature of the water is 110° F.

Chemical analysis of water, Glen Ivy Hot Springs

Magnesium chloride	trace
Sodium bicarbonate	1.548
Sodium chloride	1.271
Potassium sulphate	3.433
Calcium sulphate	1.575
Phosphates	trace

The resort is equipped with modern bathhouse with tile tubs for hot baths and also a swimming pool. Ample accommodations for guests are available at the Glen Ivy Hotel and cottages.

Bibl.: State Mineralogist's Report XXV, p. 521; U. S. Geol. Survey Water-Supply Paper 338, p. 42.

Highland Springs. The Highland Springs Resort is situated in the foothills on the south slope of San Bernardino Mountains, at an elevation of 3000 feet and is 6 miles northwest of Banning. It comprises 600 acres. Owners are F. S. and W. W. Hirsh, 646 East Eighth Street, Los Angeles.

A number of springs occur along the San Andreas fault and flow from granitic rocks.

Highland Springs mineral bath house is equipped with modern facilities for every recognized type of spa bath. Housed in a specially designed building, the baths are beautifully tiled, Roman-style sunken tubs. Near the bath house is a large swimming pool.

A ranch-type hotel and a number of modern cottages are on the property. The resort is one of the most popular health resorts in southern California. Temperature of water is 112° F.

Chemical analysis of water from Highland Springs

	Dissolved solids, grains per U. S. gallon
Silica (SiO ₂)	0.65
Aluminum oxide (Al ₂ O ₃)	0.25
Iron oxide (Fe ₂ O ₃)	trace
Calcium (Ca)	1.17
Magnesium (Mg)	0.25
Sodium (Na)	1.18
Sulphate (SO ₄)	0.34
Chlorine	0.64
Carbonate (CO ₃)	none
Bicarbonate	6.42
Total solids	10.91

Hypothetical combinations, water from Highland Springs

	Grains per U. S. gallon
Silica (SiO ₂) -----	0.65
Aluminum oxide (Al ₂ O ₃) -----	0.25
Calcium bicarbonate [Ca (H ₂ CO ₃) ₂] -----	4.75
Calcium sulphate -----	none
Calcium chloride -----	none
Magnesium bicarbonate -----	1.50
Magnesium sulphate -----	none
Sodium bicarbonate -----	2.21
Sodium carbonate -----	none
Sodium sulphate -----	0.50
Sodium chloride -----	1.00

Lakeview Inn Hot Springs. These thermal springs are located within the City of Elsinore. Hot sulphureted water is obtained from shallow wells. Lakeview Hotel has accommodations for about one hundred guests. Bath house is equipped with mud and tub baths.

Chemical analysis of water, Lakeview Inn Hot Springs

	Original Hot Springs grains per gallon	White Sulphur Springs grains per gallon
Total residue by evaporation-----	19.82	19.40
Soluble in water after evaporation	13.12	11.88
Insoluble in water after evaporation	3.79	5.24
Organic matter and chemically combined water -----	2.91	2.33
The soluble parts consist of sodium and potassium sulphates -----	7.07	4.09
sodium chloride -----	3.33	5.07
sodium carbonate -----	2.67	2.67
The insoluble parts consist of calcium sulphate Calcium and magnesium carbonates } -----	1.92	2.33
Silica -----	1.87	2.91

Bibl.: State Mineralogist's Report XXV, pp. 522-523.

Murrieta Hot Springs. This famous health resort and springs are situated on the Temecula Rancho, 4 miles east of Murrieta; elevation 1309 feet. Owner is Guenthers' Murrieta Hot Springs, Murrieta, California.

Four flowing hot springs occur along the Elsinore fault zone. The rolling hills are of granitic material that are covered in part by gravels of Quaternary age. The hot waters, which are distinctly sulphureted in odor and taste, rise at the base of a gravel bluff. Four springs that rise within 30 feet of each other, with a maximum temperature of 170° F., furnish an ample supply of water for bath houses and open-air swimming pool. The principal springs are known as Sulphur Springs, Cripple Creek Springs, Kidney Spring, and Cold Water Canyon Springs.

Chemical analysis of water of Sulphur Springs (The Siloam), temperature 170° F.

	Constituents per 100,000	Grains per U. S. gallon
Sulphate of lime -----	2.14	1.25
Carbonate of lime -----	0.69	.40
Carbonate of magnesia -----	trace	trace
Iron -----	0.52	.30
Soluble silicate -----	6.00	3.50
Chloride of sodium -----	60.10	35.50
Carbonate of sodium -----	2.83	1.65
Hydrogen sulphide and carbonic acid -----	5.15	3.00
Total -----	77.43	45.00

Since last report on the property a new modern bath house has been built, with hot mineral-water tile baths and tule mud baths. Accommodations consist of the new main hotel and remodeled California Hotel and Monterey Hotel; also detached cottages and bungalows.

Bibl.: State Mineralogist's Report XXV, p. 523; U. S. Geol. Survey Water-Supply Paper 338, p. 44.

Palm Springs. The springs are located at the southern base of San Jacinto Mountains and it is the most famous desert resort in southern California. The water has a temperature of about 100° F.

Chemical analysis of water, Palm Springs

Constituents	By weight	Reacting values
Sodium (Na) -----	158	6.87
Lithium (L) -----	trace	trace
Calcium (Ca) -----	trace	trace
Magnesium (Mg) -----	trace	trace
Sulphate (SO ₄) -----	trace	trace
Chloride (Cl) -----	188	5.30
Carbonate (CO ₃) -----	47	1.57
Silica (SiO ₂) -----	trace	trace
Total -----	393	

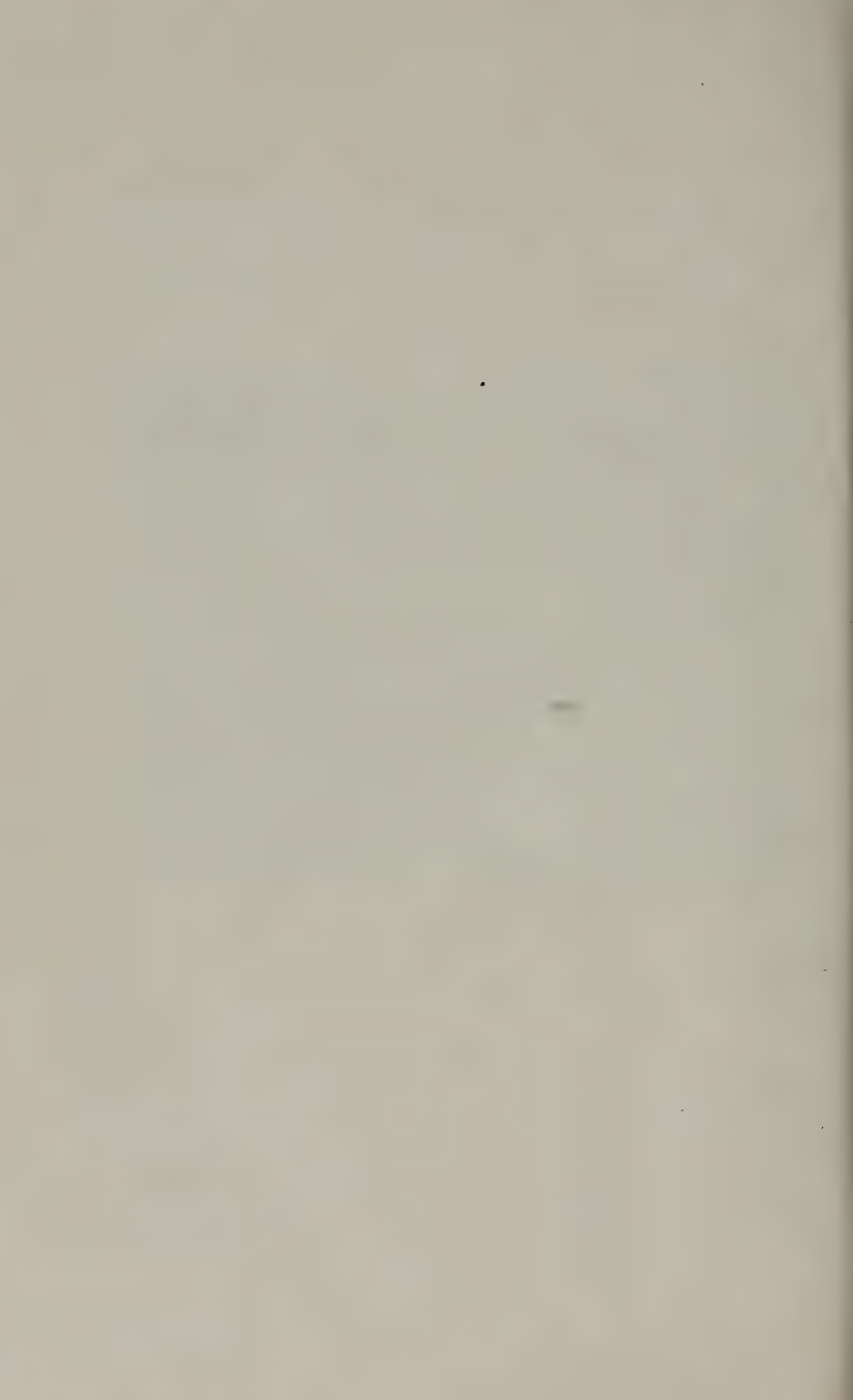
Bibl.: State Mineralogist's Reports XV, p. 581; XXV, p. 523; U. S. Geol. Survey Water-Supply Paper 338.

Soboba Hot Springs. The resort and springs are situated in the foothills of San Jacinto Mountains, 2½ miles northeast of San Jacinto; elevation 1660 feet; John G. Althouse, owner and manager, San Jacinto, California.

Six springs which range in temperature from 70 to 118° F., occur along the San Jacinto fault and flow from granitic rocks. Natural hot mineral waters of varied analyses and excellent therapeutic value flow from several springs at Soboba. The drinking of the hot mineral water, combined with the steam, mineral, and mud baths, provides a natural system of pronounced value in the treatment of ailments and diseases. The Soboba water is classed as a sodic carbonated alkaline, silicious. It is reported that the waters have been used with excellent results in treating acid dyspepsia, rheumatism, gout, and diabetes. Such waters are also of value in breaking up and eliminating uric acid and uric acid deposits.



SWIMMING POOL, SOBOBA HOT SPRINGS, SAN JACINTO,
RIVERSIDE COUNTY



Chemical analysis of waters, Soboba Hot Springs

	Parts per million
Sodium carbonate -----	82.5
Sodium sulphate -----	64.1
Sodium chloride -----	30.5
Sodium carbonate -----	3.3
Sodium arsenate -----	0.059
Sodium nitrate -----	0.016
Sodium nitrate -----	0.004
Lithium -----	trace
Silica, iron and aluminum oxides -----	55.86
Volatile and organic matter -----	31.2
Total, parts per million -----	268.039

Soboba Hot Springs is equipped with a complete bath house, with tile tubs for mineral and mud baths; also large swimming pool. There are accommodations for guests in the ten lodges of the Indian Village and a number of hollow-tile bungalows and cottages.

Bibl.: State Mineralogist's Report XXV, p. 23; U. S. Geol. Survey Water-Supply Paper 338, p. 39.

Wrenden Hot Springs (Elsinore). Formerly known as Bundy's Elsinore Hot Springs, this resort is situated in the town of Elsinore. Shallow wells supply warm water for drinking and a new, complete bath house. The hotel is a modern building of hollow tile, with accommodations for 100 guests; under the management of Mr. and Mrs. E. M. Popovich, Elsinore, California.

Partial analysis of water, (temperature 112° F.), Wrenden Hot Springs

	Grains per U. S. gallon
Sodium and potassium sulphates -----	5.02
Sodium chloride -----	1.64
Sodium carbonate -----	6.19
Calcium and magnesium carbonates plus calcium sulphate -----	2.04
Silica -----	3.51
Organic matter and chemically combined water -----	0.88

*Constituents in part per million, by weight, Wrenden Hot Springs***Soluble in water**

Sulphate (SO_4) -----	55
Chloride (Cl) -----	17
Carbonate (CO_3) -----	60
Sodium (Na), and potassium (K) -----	88

Insoluble in water

Silica (SiO_2) -----	60
Calcium (Ca), magnesium (Mg), sulphate (SO_4), and carbonate (CO_3) chiefly calcium -----	35

The waters are soft, chiefly primary saline in character.

Bibl.: State Mineralogist's Report XXV, p. 523; U. S. Geol. Survey Water-Supply Paper 338, p. 43.

Sericite Schist

Whitewater Sericite Schist Deposit. This deposit comprises 3 claims on Painted Hill east of Whitewater River, in secs. 35-36, T. 2 S., R. 3 E., S. B., 4 miles north of Whitewater, on U. S. Highway 60; elevation 2200 feet.

A white, micaceous schist occurs as a series of lenses in zone between gneissoid granite and diorite. These lenses of sericite schist which are a clear white, soft material, have widths varying from 6 to 20 feet. The zone strikes N. 30° W. and dips 45° W. The material in this zone is kaolinized and occurs in scales and plates; color is white, with pearly luster. Idle.

Talc

Palen Mountains Talc Deposit. This deposit comprises 2 claims situated on the southwest slope of Palen Mountains, in sec. 8?, T. 5 S., R. 18 E., S. B., 18 miles northeast of Desert Center and 32 miles northwest of Blythe. Owners are E. T. Herman, El Segundo, California, and Leslie C. Mott, Los Angeles; elevation 1400 feet.

A vein of talc occurs along a shear zone on contact of lime-silicate rocks and schist. It strikes east and dips 40° S. Width is 30 to 60 feet and can be followed along the outcrop for a distance of 3000 feet. The talc is white to gray and is soft. A siliceous outcrop occurs along the hanging wall of the talc in schist. Development consists of open cut 30 feet long and a crosscut tunnel driven 30 feet S. 30° W. to hanging wall, developing 60 feet of talc. In the tunnel a winze has been sunk 10 feet in talc.

Samples taken by owners gave the following analysis:

	Percent
Silica (SiO_2) -----	60.70
Iron and aluminum oxides (Fe_2O_3 and Al_2O_3) -----	1.95
Calcium oxide (CaO) -----	trace
Magnesium oxide (MgO) -----	30.88
Water (H_2O) -----	4.50

Idle.

SPECIAL ARTICLES

RECENT LEGISLATION AFFECTING MINING

AN ACT TO PROVIDE FOR BASIC TOPOGRAPHIC MAPPING OF THE STATE OF CALIFORNIA AND MAKING AN APPROPRIATION THEREFOR.

Chapter 1424, Statutes of 1945

(Senate Bill No. 803)

(Approved by the Governor July 17, 1945)

The people of the State of California do enact as follows:

SECTION 1. It is hereby declared to be the policy of the State of California to provide for basic topographic map coverage in aid of development and conservation of the natural and economic resources of the State.

SEC. 2. The Department of Public Works, hereinafter referred to as "department," acting by and through the State Engineer, shall investigate mapping; shall prepare a complete report thereon including plans and recommendations for an adequate mapping program for California; and shall adopt a general plan and program for the accomplishment of the policy declared in this act. The general plan and program so adopted, and as from time to time modified, amended or revised by the department, shall be the authorized general plan and program to be carried out by the department. The department may from time to time make such further investigations and reports upon mapping as deemed proper by it in pursuance of the policy declared in this act.

SEC. 3. All map production work to be undertaken hereunder shall be in cooperation with the Federal Government and with the approval of the Department of Finance, the department may enter into agreements or contracts with the Federal Government or any agency or agencies thereof for performance of map production work in accordance with the general plan and program adopted hereunder.

SEC. 4. For the purpose of carrying out the provisions of this act the sum of three hundred thousand dollars (\$300,000) is hereby appropriated, out of any money in the State treasury not otherwise appropriated, to the Department of Public Works for expenditure during the Ninety-seventh and Ninety-eighth Fiscal Years. Except for investigations, reports and other administrative expenses of the department in an amount not to exceed 5 per cent of the moneys hereby appropriated, none of the moneys hereby appropriated shall be expended unless and until moneys equal to or in excess of the amounts expendable from this appropriation shall have been made available (by a political subdivision, public district, municipality, county or public agency, including agencies of local and Federal Government but excluding agencies which are a part of the executive department of the State Government) for expenditure

by the department for work of map production to the end that any sums expended from this appropriation shall be matched by like or greater amounts from sources other than the State treasury or funds of any agency which is a part of the Executive Department of the State Government; provided that when the United States or any agency thereof matches funds it shall not be required that funds to be provided from Federal sources shall be paid into the State treasury.

The appropriation herein made shall be expendable for paying expenses incurred pursuant to an agreement hereunder or for reimbursing the United States or any agency thereof for expenses paid pursuant to such an agreement, but shall not be advanced to the Federal treasury or to the funds of any Federal agency, or otherwise advanced.

AN ACT RELATING TO RELIEF FROM CERTAIN OBLIGATIONS AND EXTENSIONS OF TIME FOR CERTAIN ACTS AND PROCEEDINGS INCLUDING PROVISIONS TO EXTEND THE PERIOD OF THE OPERATIVE EFFECT OF CHAPTER 207 OF THE STATUTES OF 1943 RELATING TO GOLD AND SILVER MINING BY AMENDING SECTIONS 1, 7, 8, 10, 12, 13, 17, 21 AND 27 OF SAID CHAPTER 207 AND TO REPEAL CERTAIN ACTS, RELATING TO CHATTEL MORTGAGE, MORTGAGE AND TRUST DEED MORATORIA.

Chapter 294, Statutes of 1945

(Senate Bill No. 167)

(Approved by the Governor May 8, 1945)

The people of the State of California do enact as follows:

SECTION 1. Section 1 of Chapter 207 of the Statutes of 1943 is amended to read:

Section 1. Due to the necessity of conserving labor and strategic materials in connection with the war effort, the United States War Production Board has issued an order directing the cessation of operations of gold mines throughout the United States. The issuance of this order has caused widespread distress among the gold miners of California, and the Legislature finds that as a war measure it is necessary to provide for the relief of said distress in the following manner until causes of said distress have been removed by cessation of the war.

This act shall, therefore, be effective until six months after the termination of hostilities between the United States and all nations with which the United States is at war as determined by an act of Congress or proclamation of the President of the United States, or until October 1, 1947, whichever first occurs.

SEC. 2. Section 7 of said chapter is amended to read:

Sec. 7. Upon application of the petitioner, after service of such petition, or upon application of any other interested party after the filing of the petition, a hearing shall be had thereon within 20 days after such application, upon such notice as the court shall reasonably prescribe; provided, however, that the court if it finds equitable grounds therefor, may postpone such hearing for not to exceed 10 days.

After the filing of such petition and the recording and mailing of the notice of the pendency thereof as provided in Sections 5 and 6 of this act, no sale under the power of sale conferred by such deed of trust or such mortgage or other instrument shall be held nor shall any forfeiture be effected under any of the instruments set forth in Section 2 hereof until the court makes its order in the matter, but nothing herein contained shall prevent such sale or forfeiture at any time after October 1, 1947, or six months after termination of the war, whichever shall first occur.

SEC. 3. Section 8 of said chapter is amended to read:

Sec. 8. Upon such hearing the court may make its order, if it finds equitable grounds for relief, and finds that the security will not be unreasonably jeopardized thereby, ordering that such sale shall not be held or forfeiture declared until after such date as the court considers just and equitable, but in no event shall such date be beyond October 1, 1947, or six months after termination of the war, whichever first occurs, or may make its order dismissing such proceedings.

If the court orders the sale or forfeiture postponed it shall determine the reasonable value of the income from such property, or if the property has no income, then the reasonable rental value of such property, or if the property is unimproved, a reasonable sum to be paid by the trustor or mortgagor, or holder under other instrument set forth in Section 2 hereof, as determined by the court, and by such order shall require the trustor or mortgagor to pay all or at least a reasonable part of such income, rental value, or sum so determined by the court, in or toward the payment of taxes, insurance, interest, or principal of the indebtedness at such times and in such manner as are determined to be just and equitable under the circumstances.

SEC. 4. Section 10 of said chapter is amended to read :

Sec. 10. When any mortgage or deed of trust upon property, or upon machinery and equipment attached to or used in operating gold or silver mining property or other instrument, has been foreclosed, and the property covered thereby has been sold in whole or in part under decree of foreclosure, and the period of redemption has not yet expired, the mortgagor or trustor thereof, or holder under other instrument set forth in Section 2 hereof, having the right of redemption, may at any time not later than October 1, 1947, or six months after termination of the war, whichever first occurs, file a petition in the superior court of the county in which the property so sold or the major portion thereof is situated, praying for an order extending such period of redemption.

SEC. 5. Section 12 of said chapter is amended to read :

Sec. 12. Upon application of the petitioner after service of such petition, or upon application of any other interested party, after the filing of the petition, a hearing shall be had thereon within 20 days after such application, upon such notice as the court shall reasonably prescribe; provided, however, that the court, if it finds equitable grounds therefor, may postpone such hearing for not to exceed 10 days.

Upon the filing of such petition and the recording and mailing of the notice of pendency thereof as provided in Sections 10 and 11 of this act, the period of redemption, if such period would sooner terminate, shall be extended until 10 days after the court makes its order in the matter, but in no event beyond October 1, 1947, or six months after termination of the war, whichever first occurs.

SEC. 6. Section 13 of said chapter is amended to read :

Sec. 13. Upon such hearing the court may make its order, if it finds equitable grounds for relief and finds that the security will not be unreasonably jeopardized thereby, extending such period of redemption for such additional time as the court considers just and equitable, but in no event beyond October 1, 1947, or six months after termination of the war, whichever first occurs, or may make its order dismissing such proceeding.

If the court by its order extends the period of redemption, it shall determine the reasonable value of the income from such property, or if the property has no income, then the reasonable rental value of such property, or if the property is unimproved, a reasonable sum to be paid by the operator as determined by the court.

The court shall require the operator to pay all or at least a reasonable part of such income, rental value, or sum so determined by the court, in or toward the payment of taxes upon such property, the cost of insurance and the sums to which the purchaser of such property at such fore-

closure sale, or the last redemptioner, as the case may be, is entitled under the provisions of Section 707 of the Code of Civil Procedure, at such times and in such manner determined to be just and equitable under the circumstances.

SEC. 7. Section 17 of said chapter is amended to read:

Sec. 17. In any decree rendered prior to October 1, 1947, foreclosing a mortgage or deed of trust upon real property, the court may provide that the sale of the property shall not be held until on or after such date as the court considers just and equitable, but in no event later than October 1, 1947. If the court provides in such decree that the sale shall not be held until on or after such date as it shall fix, it shall determine the reasonable value of the income from such property, or if the property has no income, then the reasonable rental value of such property, or if the property is unimproved, a reasonable sum to be paid by the trustor or mortgagor or holder under other instrument set forth in Section 2 hereof, as determined by the court, and shall require the trustor or mortgagor or holder under other instrument set forth in Section 2 hereof to pay all or at least a reasonable part of such income, rental value, or sum so determined by the court, in or toward the payment of taxes, insurance, interest, or principal of the indebtedness at such times and in such manner determined to be just and equitable under the circumstances. The court may include in such order provisions requiring maintenance and repair regulating the disposition of any income from the property, and such other provisions as it deems just and equitable for the protection of the security.

After such hearing the court, if it shall determine that it is equitable and just so to do and that the security will not be unreasonably jeopardized thereby, may make its order postponing to a date not later than October 1, 1947, or six months after termination of the war, whichever shall first occur, the foreclosure, termination or forfeiture of the petitioners' interest under such contract of purchase on substantially the same terms and conditions as those prescribed in Sections 5, 6, 7, 8 and 9 of this act, or the court may make its order dismissing such proceeding.

SEC. 8. Section 21 of said chapter is amended to read:

Sec. 21. Whenever the time within which an action may be commenced upon any obligation founded upon a written instrument secured by chattel mortgage, mortgage, deed of trust or contract of purchase, or founded upon any guarantee of such obligation or any contract of suretyship therefor or any endorsement of such instrument, would expire by virtue of Section 337 of the Code of Civil Procedure, or any other provision of law, during the period commencing with the effective date of this act and ending on the date upon which this act shall cease to be in effect, with respect to any property or chattel relating to which a petition has been filed under this act, such time is hereby extended so as not to expire until December 31, 1947, or nine months after cessation of the war, whichever shall first occur.

SEC. 9. Section 27 of said chapter is amended to read:

Sec. 27. Until October 1, 1947, or six months after termination of the war, whichever shall first occur, no receiver shall be appointed at the instance of the mortgagee of any mortgage or the trustee or beneficiary of any deed of trust, with respect to real property or chattels attached to real property subject to mortgage or deed of trust, except in a suit or action for the foreclosure of such mortgage or deed of trust

or for the enforcement of the covenants, or any thereof, contained in such mortgage or deed of trust, or in a proceeding ancillary to any such suit or action, or until after recording notice of default.

SEC. 10. The following acts are repealed :

General Laws

Year	Chapter	Page
1933 -----	1057 -----	2717
1935 -----	348 -----	1208
1939 -----	86 -----	1045
1941 -----	204 -----	1263

AN ACT TO ADD SECTION 1241.5 TO THE WATER CODE, RELATING TO
THE FORFEITURE OF WATER RIGHTS, DECLARING THE URGENCY
OF THIS ACT, TO TAKE EFFECT IMMEDIATELY.

Chapter 34, Statutes of 1945

(Senate Bill No. 418)

(Approved by the Governor April 18, 1945)

The people of the State of California do enact as follows:

SECTION 1. Section 1241.5 is added to the Water Code, to read:

1241.5. The period of time during which water appropriated for mining purposes is not beneficially used because of the suspension or limitation of the mining operations in which the water is used shall not be counted in computing the three year period referred to in Section 1241 if such suspension or limitation of mining operations is due to an order or directive of an agency of the United States.

This section shall remain in effect until the ninety-first day after final adjournment of the Fifty-seventh Regular Session of the Legislature of California.

SEC. 2. This act is hereby declared to be an urgency measure necessary for the immediate preservation of the public peace, health and safety within the meaning of Section 1 of Article IV of the Constitution of the State of California and as such shall take immediate effect. The following constitutes a statement of the facts constituting such necessity:

The United States Government has effectively prohibited the mining of precious metals in order to promote the war effort. The result has been that many mines in the State have suspended operations and as a result have ceased to use water appropriated for mining purposes. Non-use of such water for a three year period will terminate the right to use such water. Inasmuch as some of the water rights are of great value the owners of such rights will make every effort to retain them and such efforts may well lead to friction, unrest, and possible violations of the law or the Federal regulations involved. In order that the owners of these rights may be protected by law it is necessary that this act go into immediate effect.

**AN ACT RELATING TO TAXES PAID UPON MINES AND MINING CLAIMS
BY CO-OWNERS AND PROVIDING REMEDIES FOR NONPAYMENT
OF TAXES BY CO-OWNERS.**

Chapter 1292, Statutes of 1945

(Senate Bill No. 1173)

(Approved by the Governor July 11, 1945)

The people of the State of California do enact as follows:

SECTION 1. Upon the failure of any co-owner of a mine or mining claim to contribute his proportionate share of the taxes which have been levied and assessed upon the mine or claim for the period of five years, the co-owner or co-owners who have paid such share may at the expiration of the five years serve upon the delinquent co-owner notice thereof.

SEC. 2. The notice may be served either personally or by publication in a newspaper of general circulation published in the county in which the mine or claim is situated, at least once a week for 90 days, or if there is no such newspaper, in such a newspaper in an adjoining county.

SEC. 3. If prior to the expiration of 90 days from the service the delinquent fails or refuses to contribute his proportionate share of the taxes, the co-owner contributing such share may file in the superior court of the county in which the mine or claim is situated a verified petition setting forth the facts and particularly describing the mine or claim.

SEC. 4. If the mine or claim is situated in more than one county, the petition may be filed in the superior court of either county.

SEC. 5. The clerk shall set the petition for hearing by the court and give notice thereof by causing a notice of the time and place of the hearing to be posted at the county courthouse at least 10 days before the hearing. The court may order such further notice as to it seems proper.

SEC. 6. The court shall hear evidence for or against the petition and may order judgment thereon vesting the interest of the delinquent in the mine or claim in the petitioner.

SEC. 7. A certified copy of the decree may be recorded in the office of the recorder of each county in which any part of the mine or claim is situated.

AN ACT TO AMEND SECTION 10505 OF THE BUSINESS AND PROFESSIONS CODE, RELATING TO PERSONS EXEMPT FROM THE PROVISIONS REGULATING MINERAL, OIL AND GAS BROKERS AND SALESMEN

Chapter 326, Statutes of 1945

(Assembly Bill No. 233)

(Approved by the Governor May 11, 1945)

The people of the State of California do enact as follows:

SECTION 1. Section 10505 of the Business and Professions Code is amended to read :

10505. The provisions of this chapter do not apply to :

(a) Any person acting solely as a depositary under an oil or gas lease, or oil and gas lease, other than for purposes of sale.

(b) Any person who engages in any transaction pursuant to an order of a court of competent jurisdiction.

(c) Any person, and the officers and employees of such person, engaged in the business of drilling for or producing oil or gas, or of mining for or producing minerals.

(d) Any person whose activities are confined to negotiations between an owner of mineral, oil or gas lands, leases or mineral rights, on the one hand, and a person organized for the purpose of engaging in oil or gas or mineral or metal production or engaged in the business of oil or gas or mineral or metal production, on the other.

(e) Any owner of mineral rights or land, other than oil or gas rights or land, when dealing solely with his said rights or land.

MINERAL EXHIBIT AND STATISTICS

CALIFORNIA MINERAL PRODUCTION FOR 1944

By HENRY H. SYMONS *

Tabulations are presented herein showing the complete totals for all substances produced in California during the year 1944, grouped by substances and by counties. The complete detailed annual report on the mineral production of California for 1944 will be available later as Bulletin 132 of the State Division of Mines.

The total value of the mineral output of California for the year 1944 was \$469,774,525, being an increase of \$43,329,245 over the total of 1943 which was \$426,445,280. The increase was due to stimulated output owing to war demand. There were sixty-two different mineral substances, exclusive of a segregation of various stones grouped under gems; all fifty-eight counties of the State contributing to the list.

As revealed by the following, the salient features of 1944 as compared with the previous year were: Increases in total value were registered by such groups of mineral substances as fuels, industrial materials, and salines, while the metals and structural materials showed a decline in total value. The value of the year's mineral output being the largest of any on record, was due chiefly to the unprecedented war-time demand for petroleum and to the amount of natural gas utilized. The greatest annual amount and value for their output in California were registered by bromine, dolomite, gypsum, iron ore, limestone, lithia, manganese ore, natural gas, potash, pyrite, silica (quartz and glass sand), soda (soda ash and salt-cake), soapstone and talc. Petroleum and salt registered their greatest annual yield, and gold the smallest output since 1848, the year of its discovery.

Of the fuels, petroleum increased from 284,145,702 barrels, valued at \$289,323,406 in 1943, to 311,717,804 barrels, valued at \$330,659,802, an increase of 9.7 per cent in amount and 14.2 per cent in value. The 1944 output of crude oil was the largest on record but was exceeded in value by that of 1926 when the barrel value was \$1.538 compared with \$1.061 in 1944. Natural gas utilized increased from 443,219,847 M cu. ft., worth \$28,046,729 in 1943, to 467,743,258 M cu. ft., valued at \$31,797,418, and was the largest annual consumption in this State.

Of the metals, an increase in annual value was recorded by copper, lead, manganese ore, silver, and zinc; all others showed a decline in amount and value from 1943. The value of the gold yield decreased from \$5,191,480 in 1943 to \$4,108,055, which was the smallest of any year since 1848 the year gold was discovered in California. Copper increased from 17,172,440 lbs., worth \$2,232,417 in 1943, to 25,584,865 lbs. worth \$3,453,957; manganese ore increased from 25,729 long tons, worth \$957,317, to 30,263 long tons, worth \$1,098,555; and zinc increased from 5,170,627 lbs., worth \$558,427, to 16,456,103 lbs., worth \$1,875,996; while chromite decreased from 56,201 long tons, worth \$2,334,838 to 27,900 long tons, valued at \$1,190,513; quicksilver decreased from 33,948 flasks, worth \$6,177,159, to 28,097 flasks, worth \$3,178,969; and tungsten ore from 254,118 units, worth \$5,910,745, to 203,965 units, valued at \$4,835,810.

* Statistician and Curator, Division of Mines.

Of the structural materials, the group as a whole decreased from a total value of \$55,055,016 in 1943 to \$50,777,220, although increases in value were registered by granite, marble, sandstone, slate, and miscellaneous stone. Miscellaneous stone increased from a total value of \$21,716,223 to \$25,138,003, while cement decreased from 18,515,085 barrels worth \$27,865,466 in 1943, to 14,599,752 barrels, worth \$21,249,520, and brick and hollow building tile decreased from a total value of \$4,368,675 to \$3,930,662.

Of the industrial materials, the group as a whole increased in total value from \$10,656,288 in 1943 to \$11,515,327 in 1944 with all of the more important materials showing an increase in value for the year but diatomite and mineral water, both of which registered a decline.

Of the salines, this group increased in total value from \$15,660,400 in 1943 to \$20,983,104 with all materials included under this heading, such as borates, bromine, magnesium salts, potash, salt, and soda (soda ash and salt cake), showing an increase in amount and value, and only calcium chloride and iodine showing a decreased output.

Distribution by substances for 1944

<i>Substance</i>	<i>Amount</i>	<i>Value</i>	<i>No. of prop- erties</i>
Bentonite -----	25,581 tons	\$180,065	7
Borates -----	234,860 tons	5,264,864	5
Brick and hollow tile -----		3,930,662	32
Cement -----	14,599,752 bbls.	21,249,520	13
Chromite -----	27,900 long tons	1,190,513	103
Clay (pottery) -----	491,363 tons	1,241,652	36
Copper -----	25,584,865 lbs.	3,453,957	(f)
Dolomite -----	217,018 tons	619,425	4
Gold -----	117,373 fine ozs.	4,108,055	(a)
Granite -----		222,943	9
Gypsum -----	558,488 tons	949,833	10
Iron ore -----	905,981 tons	2,360,694	3
Lead -----	11,408,381 lbs.	912,670	(f)
Limestone -----	734,425 tons	1,714,414	18
Magnesium and other -----	113,927 tons (g)	4,537,381	5
Manganese ore -----	30,263 long tons	1,098,555	67
Mineral water -----	24,445,814 gals.	812,645	31
Natural gas -----	467,743,258 M. cu. ft.	31,797,418	(b)
Petroleum -----	311,717,804 bbls.	330,659,802	(b)
Pumice and volcanic ash -----	34,525 tons	272,064	14
Quicksilver -----	28,097 flasks	3,178,969	63
Salt -----	769,873 tons	2,060,960	11
Silica (glass sand and quartz) -----	274,291 tons	830,311	8
Silver -----	775,936 fine ozs.	553,910	(a)
Soapstone and tale -----	64,041 tons	824,052	13
Soda (soda ash and salt cake) -----	299,574 tons	3,647,630	5
Stone, miscellaneous -----	35,370,143 tons	25,138,003	330
Tungsten ore -----	203,965 units	4,835,810	38
Zinc -----	16,456,103 lbs.	1,875,996	(f)
Unapportioned (d) -----		10,251,752	
Total value -----		\$469,774,525	

(a) There were 109 lode mines and 66 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

(b) There was an average of 20,813 producing wells.

(c) Includes macadam, crushed rock, ballast, rubble, rip rap, sand and gravel.

(d) Includes antimony (2), asbestos (3), barite (2), bituminous rock (1), bromine (3), cadmium (1), calcium chloride (2), carbon dioxide (4), coal (2), diatomite (3), feldspar (2), fluorspar (1), gems (2), iodine (2), lithia (1), magnesite (2), marble (1), mica (1), mineral paint (2), molybdenum ore (1), potash (1), pyrite (1), sandstone (2), sillimanite (2), slate (1), strontium (2), tin (1), titanium (1), tube-mill pebbles (1).

(f) Included with gold.

(g) Includes magnesia produced prior to 1944 but not previously reported.

Distribution by counties for 1944

<i>County</i>	<i>Value</i>	<i>Number of mineral products</i>
Alameda	\$8,089,026	9
Alpine	2,214	4
Amador	283,206	11
Butte	929,239	10
Calaveras	2,642,638	12
Colusa	14,491	3
Contra Costa	3,244,179	8
Del Norte	509,703	4
El Dorado	298,859	9
Fresno	49,800,782	12
Glenn	33,736	4
Humboldt	373,525	9
Imperial	564,263	9
Inyo	6,716,413	18
Kern	108,257,342	20
Kings	13,984,044	2
Lake	468,389	4
Lassen	26,495	3
Los Angeles	108,138,154	13
Madera	74,141	9
Marin	312,849	5
Mariposa	1,306,411	8
Mendocino	152,039	5
Merced	853,905	4
Modoc	255,229	3
Mono	123,173	9
Monterey	4,942,121	7
Napa	709,686	7
Nevada	619,179	10
Orange	33,312,154	12
Placer	250,237	9
Plumas	78,714	5
Riverside	5,203,973	13
Sacramento	7,832,687	7
San Benito	1,985,039	5
San Bernardino	23,358,596	31
San Diego	1,985,932	11
San Francisco	120,000	1
San Joaquin	1,369,198	6
San Luis Obispo	704,818	7
San Mateo	2,452,525	5
Santa Barbara	23,908,079	8
Santa Clara	5,228,668	10
Santa Cruz	1,762,807	5
Shasta	2,615,373	13
Sierra	114,195	4
Siskiyou	2,507,921	9
Solano	5,973,575	3
Sonoma	905,121	8
Stanislaus	545,376	8
Sutter	89,246	3
Tehama	101,823	3
Trinity	516,066	8
Tulare	615,630	6
Tuolumne	465,734	9
Ventura	30,545,897	7
Yolo	394,299	4
Yuba	1,106,311	4
Total value	\$469,774,525	

ACCESSIONS TO THE EXHIBIT

By HENRY H. SYMONS *

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

- 21195 NATIVE MERCURY and CINNABAR from Patrick's Creek mine on Patrick's Creek, Del Norte County, California. Donor: Oscar E. Hanno. May 1945. In case 205.
- 21197 VIVIANITE ($\text{Fe}_3\text{P}_2\text{O}_8 \cdot 8\text{H}_2\text{O}$). Hydrous iron phosphate. Crystal aggregate. From New Idria quicksilver mine, San Benito County, Sulphur Spring vein. Donor: J. McLaren Forbes, Covina, California. In case 143.
- 21198 CHRYSOTILE ASBESTOS in serpentine from serpentine quarry at Easton, Pennsylvania. Donor: T. Orchard Lisle, 132-17 Maple Avenue, Flushing, Long Island, New York. In case 602.
- 21199 BISMUTHINITE (Bi_2S_3) and MOLYBDENITE (MoS_2). From 12 miles southwest of Llano, Honey Creek, Texas. Donor: Anonymous. In case 104.
- 21200 Sea-water MAGNESITE, produced at plant of Westvaco Chlorine Products Corporation, Newark, California. Donor: K. Zinn. August 1945. In case 407.
- 21201 Plaque made from sea-water magnesite by K. Zinn. Donor: K. Zinn. August 1945. In case 407.

* Statistician and Curator, Division of Mines.

LABORATORY

CARBON *

By W. B. WINSTON **

Carbon, C, is an important constituent of all solid, liquid, and gaseous fuels and of all organic compounds as well as of the mineral carbonates of which limestone is the most important. In fuels it is either free as in charcoal or combined with hydrogen, oxygen, and small quantities of other elements. The native elements briefly discussed in this paper comprise the three principal forms of carbon: diamond, graphite, and coal, as well as the inert gas carbon dioxide.

DIAMOND

Properties. This mineral, which is the hardest natural substance known is pure carbon. When burned at high temperatures in an atmosphere of oxygen only carbon dioxide is formed; out of contact with air it is transformed into graphite. It crystallizes in the cubic system, commonly as octahedrons; crystals frequently rounded or striated and with triangular depressions, often distorted, sometimes twinned. Cleavage perfect octahedral. Fracture conchoidal. It is brittle. Hardness, 10. The specific gravity in the pure and crystallized mineral is nearly constant at 3.52. Color white or colorless; occasionally various pale shades of yellow, red, orange, green, blue, brown; rarely deeply colored; sometimes black. Usually transparent; also translucent, opaque. Refractive and dispersive power high. The cause of color is not known.

There are four varieties of the diamond; diamond proper, bort, ballas, and carbonado. DIAMOND PROPER includes the well-crystallized, more or less transparent stones valued as gems. BORT is a dark, translucent to opaque, poorly crystallized diamond, often possessing a radial fibrous structure. Crystals and fragments of inferior quality unfit for gems are also called bort. BALLAS, an important industrial variety, is a special type of carbonado, in which the crystals are definitely oriented around a central nucleus; these do not cleave easily due to the structure. Ballas is extremely hard and very tough. CARBONADO comprises an opaque black or grayish black mass of microscopic crystals that interlock to form a tough homogenous material with no planes of cleavage. The specific gravity, 3.15 to 3.29, is lower than that of the diamond proper. For more detailed description consult reference (1), (6), and (7).

Tests. Diamonds may be recognized by their extreme hardness, striations on the crystal edges and faces, perfect octahedral cleavage, relatively high specific gravity, and by the greasy appearance of the uncut material and adamantine luster on the cleavage faces. They are insoluble in acids and alkalies.

Occurrence. Diamonds come chiefly from Africa, where at present over 95 percent of the world's diamonds are mined. Other deposits of commercial value occur in India and Borneo, whence came the early diamonds; Brazil, chief source of carbonado, and British Guiana are other large fields. The origin of diamonds is not clearly established. A large part has been won from aluvial diggings, associated with minerals

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** Laboratory Aide, State Division of Mines.

commonly originating in granitic rocks or veins in such rocks. The South African diamonds occur in conjunction with an eruptive peridotite, known as Kimberlite, which forms pipes or cylindrical masses ranging in diameter from over one-half mile to less than 100 feet. These pipes pierce a series of sandstone, lavas and shales. In Arkansas and in fact wherever diamonds are found in place they occur associated with basic, eruptive-rocks of a similar character. In the United States a few isolated diamonds have been found in eleven states, either in secondary deposits or in glacial drift and in three states, in rocks similar to Kimberlite. The number of diamonds found in Arkansas is estimated at between 5,000 and 10,000 stones, averaging in weight probably between 0.3 and 0.4 carat. The diamond found in gravels have become of considerable importance, and the stones command a higher average price. Diamantiferous gravels have been developed in various parts of Africa, Brazil and elsewhere. In California, diamonds have only been found in surface placers and in the drift mines. Presumably their origin has been the basic igneous rocks from which the serpentines of the gold regions have been derived. The ancient river gravels have yielded diamonds in some fifteen localities including eight counties. The largest finds being in Butte, El Dorado and Amador counties, lesser ones in Del Norte, Trinity, Plumas, Nevada, and Tulare counties. No record has been kept of the total number of stones found, but it is estimated to be between 4 and 500; all chance finds. A few stones weigh over 2 carats, but the majority are small and mostly "off color," usually with a pale-yellow tinge. For more detailed discussion consult references (6), (7), (2), and (5).

Preparation. Diamonds are recovered from alluvial deposits by washing, much in the same manner as gold. The various steps in recovering diamonds from the blue ground in South Africa are: crushing and washing, jigging, greasing or automatic-sorting, and cleaning and evaluating. The automatic diamond sorter or greaser is based upon the fact that of all the minerals in the concentrates, grease sticks most tenaciously to the diamond. It consists of a laterally oscillating and sloping corrugated iron table covered with a coat of thick grease, petrolatum. Practically all the diamonds are recovered within the first six inches. The process of diamond cutting may be divided into five stages—inspection, cleaving, sawing, cutting, and polishing. Inspection includes careful examination of the rough stones with respect to crystal form and shape, for many are distorted, rounded, or twinned; if the stone must be cleaved or sawed, the directions in which this is to be done are marked upon it with India ink. Cleaving is done with the edge of a steel plate, or "cleaving iron" by which means rough stones with shapes unsuited for advantageous cutting can be roughly formed; portions containing flaws removed; and large stones subdivided into smaller ones suitable for commercial purposes. It exacts the most careful workmanship, since a good diamond may be easily ruined by improper cleaving or careless handling. Sawing is done by means of a thin phosphor-bronze disk, two or three inches in diameter, which revolves at a speed of 2,500 to 4,000 revolutions per minute. To saw a one-carat stone usually takes about eight hours; larger stones may require several days. Cutting is as a whole, a process somewhat similar to lathe turning; the cutter must shape the stone so that, when finished, its outline and form will be attractive, and pleasing to the eye. Polishing includes the cutting or grinding of the various

facets, one by one, and imparting to them a high polish; it requires much experience and skill and a keen artistic sense; there are two groups of diamond polishers, namely, lappers and brillianteerers. Lapping and brillianteeing are accomplished by holding the stone, properly mounted, against a rapidly revolving wheel of cast iron, known as the "skeif"; diamond dust mixed with oil is fed upon the wheel, which makes from 2,000 to 3,000 revolutions per minute. The usual brilliant has fifty-eight facets. After the eighteen fundamental facets have been completed by the "lapper", the stone is finished by the "brillianteerer" who adds forty facets; in cutting these the brillianteerer does not use gauges but depends entirely upon his trained eye. For more detailed description see references 7, and 6.

Uses. Diamonds, besides furnishing the gem stone of highest value, are also used for a number of industrial purposes. In the evaluation of cut diamonds, aside from size and weight, color, make, and perfection are the important factors. In the trade, color classification may be arranged in the following order of descending values: blue (fancy blue), river (Jaeger), Wesselton (fine white), top crystal (blue white), Premier (oily body), very light brown, top Cape (silver Cape), Cape (light yellow), yellow (very dark), brown. In determining the grade of color, the stone should be viewed "edge up" over neutral white paper. A "top crystal" has been referred to as a "blue white", but shows no tinge of blue. A "Premier" viewed in sunlight will have a bluish cast due to a slight blue fluorescence. The term "make of the stone" includes an evaluation of the details of cuttings; these are adherence to proper proportions, symmetry, and finish; diamonds are sometimes classified according to seven grades. Perfection takes cognizance of the presence or absence of inherent blemishes, flaws, and other imperfections; as many as eight grades of perfection, or imperfection are recognized by some dealers. While all these factors should be carefully considered in evaluating a cut stone, the grade of color is always stressed.

Uses of diamonds for industrial purposes depend upon their extreme hardness. BORT, also called bortz or boart, is used in powdered form for bits and dies for drawing wire, glass cutting, sawing building stone, diamond-set tools, and other industrial purposes. BALLAS has many of the characteristics of carbonado and is, therefore, well adapted for drilling and industrial purposes (aside from Brazil, it is obtained principally from one mine in S. Africa). CARBONADO, also called black diamond or carbon, is much used in diamond drills for deep boring, and in diamond-set lathe tools for truing abrasive wheels and for other industrial purposes. Approximately two-thirds of the annual production of diamonds, by weight, is absorbed by industry. For more detailed description see references 6 and 7.

Marketing. Diamond production is closely proportioned to demand. Control of diamond market is maintained as a means of protecting the reputation of gem diamonds as investments. It is impossible to make a simple statement as to prices. During 1940 imported industrial diamonds ranged from \$1 to \$30 per carat. Price of gem diamonds ranged from \$5 to \$50 per carat. Price 1942, first grade cut diamonds was around \$500 per carat. The carat, originally the weight of a carob seed, is now the standardized "metric carat" of 0.200 gram. For more details on prices and statistical records consult ref. 7 and 3.

Possible Buyers. *Industrial diamonds:* Crofts Diamond Tool Corp., Boston, Mass.; Dessau Co., Maurice S., 6 Maiden Lane, New York, N. Y.; Diamond Drill Carbon Co., New York; Karelsen Inc., E., 56 W. 45th St., New York, N. Y.; Norton Co., Worcester, Mass.; Smith and Sons, J. K., Inc., 157 Chambers St., New York, N. Y.; Sperisen, Francis J., 166 Geary St., San Francisco, Calif.; Standard Diamond Tool Corp., 64 W. 48th St., New York, N. Y. *Gem varieties:* Fine and Sons, Inc., Max., 20 W. 47th St., New York, N. Y.; Kahn and Co., Land M., 608 Fifth Ave., New York, N. Y.; Sperisen, Francis J., 166 Geary St., San Francisco, Calif.; Stern Bros., Diamond Cutters Co., New York, N. Y.; Whitelaw Bros., 48 W. 48th St., New York, N. Y.

GRAPHITE

Properties. Graphite is crystallized carbon, like the diamond, but physically it differs markedly from the diamond or charcoal, the other two allotropic forms of the same element. It crystallizes in the rhombohedral division in six-sided tabular crystals, and is commonly found in embedded foliated or scaly masses; the platy structure being due to its perfect cleavage in one direction. It has a greasy feel, a metallic dull or earthy luster, is one of the softest minerals, hardness only 1-2, it is opaque even in its finest particles, black to steel gray in color, extremely resistant to the action of acids or heat (almost incombustible at temperatures below about 700° C.), and a good conductor of both heat and electricity. The average specific gravity is 2.2. The chief impurities are silica, iron, and mica. Graphite is commonly classified as natural and manufactured. Frequently the three forms of natural graphite are described as plumbago or crystalline graphite (i.e. vein or lump); as flake; and as amorphous ("black lead" or "silver lead"). Amorphous is a commercial term applied to all dull, more or less earthy varieties of cryptocrystalline graphite. Manufactured graphite, also termed "artificial graphite," is pure crystalline graphite artificially produced in the electric furnace from anthracite or from petroleum coke. For more detailed description see ref. 1, 9, and 8.

Tests. Graphite in minute isolated specks may be difficult to distinguish but larger pieces are characterized by their softness, slippery feel, black color and streak on glazed paper or porcelain. It is infusible, insoluble and of relatively low specific gravity for a mineral with metallic luster.

Occurrence. Graphite is the final metamorphic stage of all carbon minerals. It commonly occurs in schistose rocks. It may form disseminations in metamorphic rocks; pockets in metamorphic or igneous rocks; appears sometimes in pegmatite veins; and in bedded deposits. Graphite deposits are found the world over, but most occurrences are not of economic importance. Ceylon, Madagascar, and Chosen are foremost in the high quality of the material produced. Graphite occurs in many places in the United States, but the deposits are characteristically low-grade. Near Dillon, Montana, a deposit yields vein graphite similar to that of Ceylon. In California no extensive deposits of good quality graphite have been found, but small deposits of various grade have been reported from nineteen counties. In Los Angeles, San Diego, Mendocino, and Calaveras counties, graphite occurs in flakes disseminated through

schists. California flake is small, but the percentage of graphite is high and mica is practically absent. For more detailed discussion consult references 9, 8, 5, and 4.

Preparation. Graphite mines are mostly small, shallow pits or quarries. Underground mines, whether opened by shafts or tunnels, are generally worked by room-and-pillar methods. Since flake graphite is invariably associated with a high percentage of gangue material it must always be subjected to a cleaning process to prepare it for use in consuming industries. Amorphous graphite, on the other hand, can often be mined pure enough for a merchantable grade. Economical recovery of flake graphite from disseminated ore has proved one of the most baffling problems in modern ore-dressing practice, since quartz, feldspar, calcite, mica and other associated minerals differ little in specific gravity from graphite. Mica is one of the most common and also one of the most injurious impurities; it fuses readily, making pin holes in the wall of the crucible. Carbonates such as limestone are undesirable because they decompose when heated, leaving shrinkage cavities. Sulfur is decidedly deleterious as it not only causes blowholes that may result in a porous condition but also may contaminate the metal that is to be melted. The beneficiation of graphite ores usually is conducted in three stages, first producing a rough concentrate and then refining this concentrate by further grinding and a final concentration by flotation. Finished grades and classifications depend on the type of ore and separation used. Usually it is the physical character of the product that is of the greatest importance. The graphite carbon content of commercial graphite may range as low as 30 or 35 percent for the paint trade to as high as 90 or 95 percent for crucibles or lubricants. Graphite is also recovered from used crucibles and from kish. Kish is a mixture consisting of graphite, slag, iron oxide and sundry other impurities which separate from molten pig iron in the process of cooling and often accumulates in appreciable quantities at foundries and steel works and ferrosilicon furnaces. In the United States graphite is made artificially on a very large scale by the Acheson Graphite Co., Niagara Falls, N. Y. For more detailed description, see ref. 9 and 8.

Uses. Graphite is valuable to industry because of its inherent qualities, such as unctuousness; refractoriness, or ability to withstand high temperatures; conductivity of heat and electricity; inertness to a large range of reagents; and miscibility. The kinds of graphite used in the United States are: *Natural Crystalline*, LUMP and CHIP, 90 percent C—used in crucibles for melting metals, ladles, stoppers, and retorts; consumption is diminishing. FLAKE, 85 percent C—used in crucibles, carbon brushes, foundry facings, lubricants, and dry batteries; consumption is fairly large and increasing. DUST 70 percent C—same uses as amorphous; consumption insignificant. *Natural Amorphous*, 90 percent C—used in foundry facings, core washes, pencils and crayons, lubricants, paints, shoe polish and dry batteries; consumption is large and increasing. *Manufactured*. Electrodes, etc., 95 percent C. It is virtually the only form of graphite used as electrodes in electrolytic work such as the manufacture of magnesium, chlorine, caustic soda, chlorate, steel ingots, and castings; consumption is large and increasing. POWDER, 95 percent C—used in dry batteries, lubricants, commutator brushes, and in col-

loidal form, as concentrated dispersions in their carriers (water, petroleum, castor oil, glycerine and mineral spirits), it is employed in innumerable lubrication problems, ranging from locks to steam cylinders; consumption is fairly large and stationary. Graphite is an excellent lubricant, it adheres readily to metal, fills the pores, and forms a protective film which can not be squeezed out even at high-bearing pressures. In making pencil "leads" the graphite is mixed with clay which serves as a binder, and as a means of regulating the hardness and uniformity of the lead. Any impure natural graphite may be used in making paint. Graphite is not listed as a "strategic" mineral, but is included in the "critical" group. For more detailed description see references 8, 9, and 2.

Marketing. Graphite consumption in the United States is seldom more than 30,000 short tons annually, valued at about one and a half million dollars. Prices of domestic graphite are at present controlled by the O.P.A. The Metals Reserve Co., price list per pound, for domestic flake of specific grades is as follows: No. 1 A, 14 cents; No. 1, 13 cents; No. 2, 11 cents; No. 3, 7 cents; and No. 4, 5 cents. Amorphous ranges from 2 to 4 cents per pound, depending on the carbon content. As all manufactured graphite is produced by one company, prices for this material do not appear on the open market. Army, Navy and Federal specifications for graphite used in lubricants are given in reference 8; for more detailed price statistics see also 9, and 3.

Possible Buyers. Some possible buyers of graphite are given in the following: Acheson Graphite Corp., 30 E. 42d St., New York, N. Y.; Alatary, A. D., 10 Bridge St., New York, N. Y.; Ashbury Graphite Mills, Ashbury, N. J.; Dixon Crucible Co., Joseph, Jersey City, N. J.; Great Lakes Carbon Corp., 22 E. 40th St., New York, N. Y.; Ilsley, Doubleday & Co., 56-14 Nurge Ave., Maspeth, L. I., N. Y.; International Selling Corp., 67 Broad St., New York, N. Y.; Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.; Paterson, Boardman & Knapp, 10 Bridge St., New York, N. Y.; Shields Co., Thos. J., 11 Water St., New York, N. Y.; Superior Flake Graphite Co., 33 S. Clark St., Chicago, Ill.; Walco Co., M. E., 112 Market St., Sunbury, Pa.

COAL

Properties. Coal is the most important source of mineral carbon. It is a complex substance, since it not only contains many different kinds of plant tissue, but these together with their decomposition products, represent various chemical compounds. Mineral coal is compact, massive, without crystalline structure or cleavage. Its hardness ranges from 0.5 to 2.5. Specific gravity 1 to 1.80. Luster dull to brilliant. Color black, grayish black, brownish black and sometimes iridescent; also dark brown. On distillation most kinds give oily tarry substances, which are a mixture of hydrocarbons and paraffin. Coals are vegetable remains so preserved in sedimentary strata as to become progressively enriched in carbon C. The complete process comprises several stages. *Peat*, which represents the first stage, is formed by the growth and decay of grasses, sphagnum, and other plants in moist places. It is high in O and H and relatively low in C. Its calorific value is 3000 to 4000 cal per Kg in air-dried condition. *Lignite*, a brown coal, is a stage beyond peat; is firmer;

usually brown or sometimes yellowish in color, woody in structure, and yellow-brown streak. It has less O and H than peat and relatively more C. It contains much moisture and is often high in ash. Its calorific value as mined is 3500 to 4500 cal per Kg. It burns with a long smoky flame. *Jet* is a black variety of brown coal, with resinous luster and sufficient density to permit its being carved into small ornaments, whence its use in jewelry. Sub-bituminous coal or Black Lignite is a grade intermediate between lignite and bituminous, and is sometimes difficult to distinguish from these. *Bituminous Coal*, was formed by the further transformation of lignite by heat and pressure; is deep black, more solid, lower in O, and higher in C. It comprises many varieties, including gas, coking, steam, and cannel coal. They differ principally in their content of volatile matter. Bituminous coal burns in the fire with a yellow, smoky flame, and gives out on distillation hydrocarbon, oils and tar. Semi-bituminous and semi-anthracite mark passages to *Anthracite* in which the C is greatly enriched and the coal hard and firm. Anthracite coal was formed by the further action of heat and pressure upon bituminous coal, whereby nearly all the volatile constituents were driven off, leaving mainly carbon and mineral matter. These coals burn with little flame and no visible smoke, and do not cake. Their calorific value may be 6500 to 7500 cal per Kg. Still further stages toward graphite are known.

Coke is the residue after driving off the volatile constituents of bituminous coal, out of contact with air; it consists essentially of carbon (the "fixed carbon" of the coal) with ash and a little water, and H, O and N gas. Color, silvery gray (from long continued high heat) to dull black (from quick burning in low heat); texture, vesicular or pumice-like. It is low in volatile matter and sulfur. Upon this and its infusibility and resistance to crushing depends its value as a fuel in blast furnaces. Its calorific value is about 90 percent that of anthracite. *Charcoal* is the residue left by heating wood in retorts or partially burning it with a limited air supply. It consists mainly of carbon and the mineral matter of the wood. It contains only 0.05 percent of sulfur as compared with 1 percent of sulfur in coke. Its calorific value is about 95 per cent that of anthracite. For detailed description see references 1, 10, and 12.

Tests. COAL. Hydrocarbons, bituminous coals, and organic matter, when heated in a closed tube, usually suffer destructive distillation. Tar-like substances, oils, water, and gas are given off, and condense in the tube, while a strong empyrenmatic odor may usually be observed. The residue, if any is left, is generally nearly pure carbon. Anthracite coal and the different forms of nearly pure carbon suffer no change when heated in a closed tube, except that perhaps a little water is driven off. If the residue left in the tube forms a hard coherent, vesicular mass it would indicate a *coking coal*, while if soft and pulverulent, it would indicate a *non-coking coal*.

Occurrence. Coal occurs in beds, interstratified with shales, sandstones, and conglomerates, and sometimes limestones, forming distinct layers, which vary from a fraction of an inch to 30 feet and more in thickness. In the United States, the anthracites occur east of the Alleghany range in rocks that have undergone great contortions and fractur-

ings, while the bituminous coals are found extensively in many states further west, in rocks that have been less disturbed. Coal in commercial quantities occurs in thirty-three states, as well as in Alaska. Tertiary coals partly bituminous, though mainly lignitic, occur scattered over a wide area in the states of California, Washington, and Oregon. The separate fields are limited in extent, and widely separated. Their output is small as compared with some other states, but is of growing importance. In California coal occurs in forty-three counties. The estimated workable area comprises about 500 square miles containing 1,000,000,000 short tons. Coal of good grade has been mined in relatively large quantities in Contra Costa, Alameda and Monterey counties; and some shipments have been made from Amador, Fresno, Orange, Riverside, Siskiyou and Trinity Counties. For more detailed discussion consult references 1, 5, 10, 11, and 12.

Preparation. Coal seams, being "beds," are generally mined like bedded deposits. The purpose of coal preparation is to increase the value of fuel by making it more suitable for uses of the consumer. This is done by: screening; blending; and cleaning. By combining any two or all of these methods, coal can be prepared to standard specifications. Flotation, as applied to coal, separates fine particles of coal, pyrite, shale, and clay in a pulp. As sulfur is injurious in practically all metallurgical operations and the oxides of sulfur have a corroding effect on boiler tubes, etc., a coal high in either pyritic or organic sulfur is undesirable. With modern types of coke ovens the gaseous and liquid products formed by the destructive distillation are not allowed to escape into the air and valuable byproducts are obtained, such as ammonia, fuel and illuminating gas, and coal tar. When wood is heated in closed retorts, large amounts of tar, creosote, wood or methyl alcohol, acetone, and pyroligneous (acetic) acid, etc., are obtained; and the yield of charcoal is also nearly doubled. Activated charcoal is made by treating porous charcoal at white heat with superheated steam, which removes tarry substances. For more detailed discussion consult reference 11.

Uses. Coal is mostly used as a fuel. The carbon and the hydrogen combine, in burning, with the oxygen of the air, yielding, on complete combustion, carbon dioxide and water vapor. In general the lower the percentage of ash the better the quality of the fuel. Coals that are to be worked economically for coke may be low in volatile matter but must possess the property of partially fusing or coking together when heated in the ovens. Coke produced in the United States amounts to over 45,000,000 tons annually. The destructive distillation of soft coal is an important source not only of ammonium salts, fuel and illuminating gas, but also of a group of hydrocarbons that serve as a starting point in the manufacture of nearly all important dyestuffs. In addition to hydrocarbons, coal tar also yields large quantities of phenol (sometimes called "carbolic acid"). These compounds are all used in the manufacture of explosives, dyes, photographic films, as well as perfumes and other substances. Benzene is used as a solvent in making rubberized fabric and automobile tires. Coal tar creosote is used on a large scale for preserving wood. Charcoal is valuable in metallurgy due to its low content of phosphorus and sulfur. It is used in the reduction of iron to form a superior grade of pig iron; while acetic acid is marketed as calcium

acetate. Activated charcoal is the most efficient and most widely used adsorbent. It is used in gas masks, to adsorb toxic gases and vapors; in removing objectionable taste and odor from drinking water; in decolorizing sugar solutions; and in many similar applications in which it acts as a simple adsorbent. In addition it is a catalyzer for many reactions. For more detailed discussion consult references 11, and 3.

Marketing. Coal prices fluctuate greatly. Any attempt to insert in this short paper a statistical review of prices of coal would be confusing, for the range is wide and the varieties regularly quoted are numerous, and indication of the fluctuations which have been recorded in the last decade is found in the index of spot prices regularly published by COAL AGE. Marketing and industrial uses of charcoal is given in Chemical and Metallurgical Engineering Vol. 39, p. 664. For general prices and statistics consult reference 3.

Possible Buyers. Coal is produced in large quantities by the consumers in the steel industry and by the railroads. For possible buyers of coal the reader is referred to Coal Trade Journals and similar publications. Contracts with consumers are either for a definite tonnage or for an indefinite quantity described either as requirement, as surplus, or as mine-output contracts. The majority of the soft coal sold through a middleman is on sales-agency contracts, which in effect, make the agent the selling department of the producer.

CARBON DIOXIDE

Properties. Carbon dioxide, (CO_2) is a constituent of the atmosphere and a product of complete combustion of fuels. In normal atmospheric air it is present to the extent of 0.03 percent. It is about one and one-half times as heavy as air, and is extremely soluble in water; water at 0°C absorbs 1.71 of its volume of CO_2 . It is readily soluble in alkalis, forming carbonates and bicarbonates. Carbon dioxide gas is readily converted to a liquid by the application of pressure and moderate cooling. When the pressure is released the expansion of a portion of this liquid will cool the remaining material to a solid which is an increasingly popular refrigerant known as "dry ice." Although carbon dioxide actually has a slight pungent odor and a feebly acid taste, it is generally described as colorless, odorless and tasteless. It will not support life or combustion. It is found both free and combined with other gases, such as petroleum and flue gas.

When obtained free from impurities, carbon dioxide has physical properties as follows: Density as a solid (dry ice at -109.33°F) 97.59 pounds per cu. ft. Density as a gas at 32°F and 1 atm. pressure = 0.12341 lb. per cu. ft. Specific gravity (air = 1) = 1.52. Temperature of solid (dry ice) at atm. = -109.33°F . Refrigerating effect due to change of state from solid gas = 275 Btu. per lb. Critical point 87.8°F . and 1069.9 lb. per sq. in. Triple point, -69.88°F . and 75.13 lb. per sq. in. Weight of 1 cu. ft. air = 1.2929 oz.; compared to air CO_2 has a density of 1.52, then 1 cu. ft. CO_2 weighs, $(1.2929)(1.52) = 1.965 \text{ oz.}$, 1 oz. = 0.0625 lb., then $(1.965)(0.0625) = 0.12281 \text{ lb.}$ equivalent to the weight of 1 cu. ft. CO_2 gas. 1 cu. ft. solid CO_2 at -109.33°F . = 97.59 lb., hence $97.59 \div 0.12281 = 794.642 \text{ cu. ft. gas required for 1 cu. ft. solid } \text{CO}_2$; $2,000 \div 97.59 = 20.494 \text{ cu. ft. solid } \text{CO}_2$ in one ton, hence

$(794.642) (20.494) = 16,285.393$ cu. ft. CO_2 gas required to make 1 ton solid CO_2 . Basic data after Quinn, E. L., and Jones, C. L. Carbon Dioxide: American Chemical Society, Monograph Series, 1936.

Carbon dioxide is an important constituent of "afterdamp" (miner's term) produced by fires or explosions of gas or dust. CO_2 is given off in some metal mines, by dissolving of limestone or from carbonate minerals, sometimes giving much trouble; violent CO_2 outbursts occur in some coal mines. Carbon dioxide is quite stable at low temperatures, but at white heat it is partially decomposed into carbon monoxide and oxygen. For more detailed description see reference 15, 16; also 11.

Tests. Carbon dioxide is characterized by being a heavy, colorless, and odorless gas, which is not apt to be confounded with other gases. It does not support combustion, and when brought in contact with clear barium hydroxide solution, it gives a white precipitate of barium carbonate.

Occurrence. Carbon dioxide is constantly being added to the air by mineral springs, volcanoes, and by plant life, which takes the carbon for its tissue, and gives off oxygen. Carbon dioxide is produced on a commercial scale, approximately in the order of importance, as follows: by alcoholic fermentation (such as breweries, which gases are high in CO_2 gas content); by calcining limestone (byproduct gases, from lime kilns, cement plants, carbide plants, etc.; from combustion of coke and other fuels (flue gases resulting from combustion of fuels to produce CO_2 gas, or by burning carbon in an excess of air); natural springs and gas wells, which produce nearly pure carbon dioxide (probably the least important source); from petroleum gas which in some instances, in California, contains as much as 20 percent carbon dioxide gas. The production of natural carbon dioxide from wells is restricted by the various difficulties and losses attendant upon transportation to large consuming centers. Recovering by-product gas from lime, cement, and other process plants likewise is largely a matter of geography. Carbon dioxide gas occurs in large volumes in Utah, New Mexico, and Colorado. Igneous or volcanic rocks have been noted in the near vicinity of each of these localities. In California two localities produce carbon dioxide commercially from natural sources, the Imperial carbon dioxide gas field, Imperial County, and a locality near Ukiah, Mendocino County. The Imperial field is located near Niland, in the vicinity of five volcanic domes which rise along the southeasterly shore line of the Salton Sea. Numerous mud volcanoes, locally called "mud pots," occur here varying in size from a foot to several feet in diameter. Some emit practically only steam, others a very viscous mud which forms a cone surrounding the small opening in their center. In addition, carbon dioxide gas is given off, and deposits of sulfur and saline materials are formed around the craters. The waters have temperatures up to about 175°F . The gas at Ukiah is obtained from two wells which produce large quantities of carbonate water, the gas being trapped as it separates from the water and piped to the plant where dry ice is made. A CO_2 gas seep in Cumiskey Creek on the Beattie Ranch, Mendocino County, is reported to have commercial possibilities. A CO_2 gas seep is reported at Cloverdale, Sonoma County. For more detailed description see reference 15, 14, and 13.

Preparation. Carbon dioxide gas is segregated from a mixture of other gases by an absorption process and is then chemically purified, subjected to various stages of pressure in order to liquefy it, and is compressed ordinarily into steel cylinders containing 50 pounds of CO_2 in a liquid state, or subjected to a refrigerating cycle yielding solid CO_2 or dry ice. Compressed sufficiently and held at temperatures ranging from -69° to 89° F., carbon dioxide exists in liquid form; above 89° F., it is impossible to maintain it in liquid form, no matter how it is compressed. If liquid CO_2 is held in a pressure vessel partly filled, and the space above the liquid is filled with CO_2 gas (vapor), the pressure exerted depends on the temperature; it ranges from 80 pounds per sq. in. at -60° F. to approximately 1050 lbs. per sq. in. at 88° F., and is about 291 lb. per sq. in. at 0° F. When the liquid CO_2 is released to atmospheric pressure, the percentage of "snow" formed depends on the temperature of the liquid released. In the multiple cylinder systems the cylinders are manifolded together with operating and control valves and fixed piping provided with nozzles for discharge of the gas. These systems have an excellent record of fire extinguishment. Reduction of the oxygen of the air from the natural 21 per cent to 15 per cent by the addition of carbon dioxide will extinguish ordinary liquid fires. The bulk low-pressure method of handling carbon dioxide makes it possible to store, transport and transfer refrigerated liquids economically. Carbon dioxide surrounds the material to be refrigerated with an insulating atmosphere of dry gas; for this reason its refrigerating effect is about 10 times that of an equal weight of a mixture of ice and salt. In the manufacture of dry ice from natural carbon dioxide, Imperial county, the gas from the field enters the plant at the collecting tank, whence it passes through cooling towers, and two stages of compression, before it becomes liquid in the condensing chamber. From the liquid carbon dioxide storage chamber, it flows to an expansion valve in the wall of the "snow" chamber; this chamber, an integral part of an hydraulic press, is cube shaped with the upper and lower sides attached to hydraulic cylinders. The hydraulic rams compress the snow into a block of solid dry ice, which is transferred to the saw table and there cut and packed; the usual block for shipping measuring 10 x 10 x 10 inches. For more detailed description see refs. 15, 14, 13, and 11.

Uses. Carbon dioxide is marketed either as a solid (dry ice) or as a liquid (liquid carbonic), which, if so required, is sublimed or reduced to a gas at the place of use. The principal common uses of carbon dioxide are: *Solid CO_2* —REFRIGERATION, which is the main outlet for dry ice, includes package refrigeration, truck, railroad, ice cream dispensers, etc.; widely used in the transportation and storage of food products. *HEAT and COLD TREATMENT*, in the hardening of metals, shrink fitting of machine parts and cylinder liners. *LABORATORY USES*, as in dehydration of biological serums, thin sections, etc.; *Liquid CO_2* —REFRIGERATION, as in compression refrigeration systems; exceptionally dependable, with no danger to life from leakages, but requires about 830 pounds pressure per square inch at 20° C., to remain in liquid state, as compared to about 120 pounds for ammonia and 46 lbs. for sulfur dioxide; preferred for certain large-scale installations, as in ships, hotels, theaters, etc. *BLASTING*, as in "Cardox Blasting"; used in coal mines, the cost is greater than black

powder but is safer and does not break up the coal as much. POWER, as bottled power for any purpose in which compressed air is generally used. *Gaseous CO₂*—CARBONATING BEVERAGES, perhaps the second largest use in point of volume; carbonated water, soda pop, etc. FIRE EXTINGUISHING, will extinguish quickly all fires except those occurring in chemically-treated material to which sufficient oxygen to support combustion has been added. PRESERVATION, conservation of food products, flowers, etc., may all be prolonged by the proper treatment with carbon dioxide gas. Treatment also assists in preventing spoilage in canned goods subject to spoilage by oxidation, such as cocoa products, coffee, powdered milk, etc. CHEMICALLY, mostly for the manufacture of carbonates; in the solid form, carbon dioxide is the only cheap, non-corrosive, acid anhydride which can be shipped without special containers and handled easily with entire safety. POWER, if used as a source of power to project liquid sprays onto trees and plants, will stimulate respiration of insects, making poisonous gases more effective; will increase plant growth, reduce fire and explosion hazard when mixed with inflammable fumigants, and is a type of indirect fertilizer. Carbon dioxide in either the Gaseous or solid state has been used with beneficial results in numerous human ills. For more detailed description see references, 15, 14, and 13.

Marketing. Carbon dioxide prices as published by the United States Department of Labor show an average annual price of \$0.06 per pound for liquid in cylinders, large lots, f.o.b. New York. Bulk low pressure storage of CO₂ for fire protection systems, reduces the cost to approximately \$35 per ton, depending on the locality, or approximately \$0.02 per pound.

Possible Buyers. Carbon dioxide buyers as listed in the Green Book Buyers Directory include the following: Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y.; The Liquid Carbonic Co., 3100 South Kedzie Ave., Chicago, Ill.; The Matheson Co., 335 Paterson Plank Road, East Rutherford, N. J.; Monsanto Chemical Co., 1724 So. Second St., St. Louis, Mo.; Pacific Silicate Co., Ltd., 215 Market St., San Francisco, Calif.; Puritan Compressed Gas Corp., 2012 Grand Ave., Kansas City, Mo.; the S. S. White Dental Mfg. Co., 211 So. 12th St., Philadelphia, Pa.

Selected References. For more complete discussion the following references, some of which give extensive bibliographies, have been selected.

CARBON REFERENCES

General

1. Ford, W. E., *Dana's Textbook of Mineralogy*: John Wiley & Sons, New York, N. Y., 4th Ed., 1932.
2. *Industrial Minerals and Rock (nonmetallic other than Fuels)*: (Seely W. Mudd Series). Am. Inst. Min. Met. Eng., New York, 1937. Contains selected bibliography.
3. *Minerals Yearbook*: U. S. Bur. Mines. Annual publication presenting a record of development and trends in the mineral industry, with statistical details.
4. Pabst, A., *Minerals of California*: Calif. State Div. Mines, Bull. 113, 1938. Brief descriptions of occurrences.
5. Ries, H., *Economic Geology*: John Wiley and Sons, Inc., New York, 1939. Extensive bibliographies.

Diamond

6. Kraus, E. H., and Slawson, C. B., *Gems and Gem Materials*: McGraw-Hill Book Co., Inc., N. Y., 1939. Many colored illustrations.
7. Tyler, Paul M., *Abrasive and Industrial Diamonds*: U. S. Bur. Mines Inf. Cir. 6562, 1932. A detailed discussion of entire subject; extensive list of dealers and consumers.

Graphite

8. Gwinn, G. Richards. *Graphite—Natural and Manufactured*: U. S. Bur. Mines, Inf. Cir. 7266, 1943. A brief discussion of entire field; extensive list of domestic producers.
9. Tyler, Paul M., *Graphite*; Part I, General Information: U. S. Bur. Mines Inf. Cir. 6118, 1929. (Contains extensive bibliography). Part II, Domestic and Foreign Deposits. Inf. Cir. 6122, 1929. Part III, Utilization of Graphite: Inf. Cir. 6123, 1929. Part IV, Status of the American Graphite Industry: Inf. Cir. 6124, 1924. (Contains list of domestic graphite mines and producers).

Coal

10. Coal deposits in the State of Calif., with References: (Manuscript report in files of Calif. State Div. Mines), 1943.
11. Peel, Mining Engineers Handbook. Coal: John Wiley & Sons, Inc., New York, 1941.
12. White, David, and Reinhardt, T. The Origin of Coal: U. S. Bur. Mines, Bull. 38, 1913.

Carbon Dioxide

13. Cardox Corp. Carbon Dioxide in Engineered Fire Extinguishing Systems: Cardox Corp. Bell Bldg., Chicago, Ill. (These trade papers give much technical information and are well illustrated).
14. Hendricks, R. W., New Developments in Carbon Dioxide Protection: Proceedings 45th annual meeting, Toronto, pp. 1-7, May 1941. Nat'l. Fire Protection Assoc. 60 Batterymarch St., Boston, Mass.
15. Roak, S. H., and Williams, G. G.: Imperial Carbon Dioxide Gas Field: Calif. State Div. Oil and Gas, California Oil Fields, Vol. 28, No. 2, pp. 13-33, 1942. (Very complete paper with foot notes).

Current Literature

For coal, charcoal and carbon dioxide, see current numbers of: *Industrial and Engineering Chemistry*; *Chemical and Metallurgical Engineering*; *Journal of Chemical Education*; *Chemical Review*; *The New Coal Age*, Smithsonian Reports.

NOTE.—Books, government publications and some current literature containing information on the minerals of the carbon group may be consulted at the California State Division of Mines, Ferry Bldg., San Francisco. Specimens of these minerals, and of the rocks in which they occur, may also be seen in the mineral exhibit of the Division.

FLUORSPAR *

By W. B. WINSTON **

Properties. Fluorspar or fluorite is calcium fluoride (CaF_2) and contains, when pure, 48.9 per cent fluorine (F) and 51.1 per cent calcium (Ca). The mineral usually occurs in crystalline masses and frequently in well-formed crystals; less often in granular form. It is commonly found in veins and often associated with ore minerals, especially lead, silver and zinc. Most commercial fluorspar contains silica or calcite, or both, and usually some iron oxide or alumina. Other more or less common associated minerals are quartz, calcite, barite, galena, and sphalerite. It has a wide range of color. In large deposits white and gray fluorspar are probably the most common. In narrow veins, and often in well-crystallized deposits in siliceous rocks, green and purple fluorspar are common. Other colors seen are blue, yellow, orange, red, pink, brown and black. The causes of this variation in color are not known. The hardness is 4, and the specific gravity 3.01 to 3.25. It crystallizes in the isometric system, usually in cubes, the crystals having a pronounced cleavage. Melting point $1,270$ to $1,387^\circ \text{C.}$, index of refraction 1.434, streak usually white, but pinkish in all purple varieties, luster vitreous, dull, or earthy when the mineral is granular, rarely submetallic, fracture conchoidal to splintery. It is transparent or translucent to nearly opaque. Brittle. Most fluorspar flies apart when heated. The phenomenon of fluorescence is shown by some varieties.

Fluorspar and cryolite, a sodium-aluminum fluoride (Na_3AlF_6), 54.4 per cent fluorine, are the only minerals that contain large portions of fluorine. Only one large deposit of cryolite is known, in Greenland, and the mineral can not be considered a substitute for fluorspar in large amounts. The term fluorite, which is now probably in widest use in works on mineralogy, seems to suggest the pure mineral, but in commercial practice the name fluorspar is used almost exclusively. In some places the term "spar" is often used, especially by miners, to denote fluorspar. For detailed discussion consult Dana's "Textbook of Mineralogy." Also reference (2).

Tests. Fluorite is fusible at 3, and residue gives alkaline reaction to moistened turmeric paper. Gives a reddish flame (calcium). When it is mixed with potassium bisulfate and heated in a bulb tube, hydrofluoric acid is evolved which etches the glass, and a white deposit of silica forms upon the walls of the tube.

Occurrence. Although fluorite is widely distributed in minute quantities, deposits containing a large proportion of the element are uncommon. Fluorspar, the only fluorine mineral of great commercial importance, is found under a great variety of geological conditions. Virtually all important deposits are in or near fault fissures. They may exist as fillings or fissures, as replacements of the walls, as replacements of favorable sedimentary beds in or near the zone of faulting, as fillings of solution cavities near faults, and as residual deposits left by weathering of deposits formed as above. Some evidence of igneous activity is to be seen at or near most of the important fluorspar deposits. Limestone beds or calcite veins are the most favorable places for the

* Reprinted from State Division of Mines Bulletin 124, *Commercial Minerals*. Available also as a separate, mimeographed.

** Laboratory Aide, State Division of Mines.

formation of large deposits. Most deposits in igneous rocks are small, narrow and nonpersistent. All available evidence seems to show that, in general, important deposits of high-grade fluorspar are not to be expected in highly siliceous rocks, either igneous or sedimentary.

In the United States fluorspar is found at a number of points in the Piedmont and Appalachian areas from Maine to Virginia, and also (usually in small amounts) in many metalliferous veins of the West. But the most important fluorspar-producing region in the United States and probably in the world is the Illinois-Western Kentucky district. Relatively small production comes from mines in Colorado, New Mexico, Arizona, Texas, Nevada, Utah, Washington and New Hampshire. In California fluorite is rare. Minor occurrences are reported from several places, most of them widely scattered within the southern half of the State. Most of these are in connection with other mineral deposits, such as lead-zinc, and not of commercial value. Near Afton, in San Bernardino County, the fluorspar is associated with fine-grained andesitic rocks, which occur as intrusions and as flows over coarse sandstone, sometimes conglomeratic. For more detailed discussion see references (2), (5).

Preparation. In prospecting for fluorspar, test pits and shafts have probably been used more than any other method and they have found most of the ore deposits now worked. Although the methods used in mining fluorspar differ greatly in different mines and in different districts, all mines may be divided into three main groups: open-cut mines; mines opened by drifts or tunnels; and mines opened by shafts—by far the most common method. The methods of concentrating or milling fluorspar depend upon the nature and amount of associated impurities and upon the type of the ore. Harmless impurities or diluents include calcite or any form of calcium carbonate; silica in any form; silicates and aluminosilicates, such as feldspar, which do not contain large amounts of the metals; wall rocks, such as granite, slate, shale, and so on; clay and sand. Injurious impurities include: barite; galena; sphalerite; pyrite; all other sulfides and sulfates; all other lead and zinc minerals; all iron compounds (in glass and enamel grade spar). In general there are three principal types of ore: Residual and (or) disintegrated or mixed with sand and clay; massive crystalline ores, in which the fluorspar is easily separable from the gangue minerals; and hard mixed ores in which the fluorspar is intimately associated with other vein minerals or with fragments of wall rocks (breccias).

The fluorspar is prepared for market by selection in the mine, crushing, washing with jets of water or in log washers, hand picking on belts, screening, gravity concentration by jigs and tables, and flotation. The grades produced are: Acid grade, the highest grade of commercial fluorspar, except optical spar; American lump No. 1, with under 1 percent silica, and sold mainly to glass, enamelling, and chemical industries. American lump No. 2, which includes colored spar; and usually sold under a 3 percent silica guaranty. Used by blast furnaces in the production of ferrosilicon and ferromanganese, and in basic open hearth steel furnaces. Gravel spar, including all with over 4 percent silica, and spar mixed with calcite, used in iron and brass foundries. Ground fluorspar is packed in bags or barrels for shipment and gravel-grade is loaded into railroad cars. Shipment from domestic mines in 1939 aggregated over

180,000 tons valued at a little over \$3,700,000. For more detailed discussion consult references (2), (5), and (6).

Uses. The steel industry is the chief consumer of fluorspar in the United States, followed in order by the hydrofluoric acid, glass, enamel and miscellaneous industries. The metallurgical uses of fluorspar depend in part upon its relatively low melting point. In the steel industry it is added as a flux to the furnace charge. It gives fluidity to the slag, and assists the elimination of objectionable impurities, as sulfur and phosphorus. For cupola work in the foundry, fluorspar has a similar use. Large quantities of fluorspar are used in the manufacture of hydrofluoric acid (HF), for which purposes it is sold either ground or in lump or gravel form (acid lump, acid gravel, or "Keystone" grade). Hydrofluoric acid in turn is replacing sulfuric acid as a catalytic agent in the manufacture of hi-octane gas. Lower temperature and pressure are obtained by its use as a catalyst instead of high temperature and high pressure as heretofore required. In the glass industry fluorspar is used chiefly in making opalescent or opaque white glass and colored or cathedral glass. Similarly high-grade fluorspar is an important constituent in dense, opaque, white and colored enamels used in coating sheet iron and steel, and cast-iron sinks, tubs, trays, kitchenware, and so on. It is also used in making enamel brick and tile and for other ceramic purposes where an opaque, easily fusible enamel is needed. A relatively small but important use for clear, transparent, nearly colorless fluorspar is for the manufacture of certain types of lenses. Large amounts of a rather low-grade acid fluorspar are employed in the manufacture of artificial cryolite, which is used with natural cryolite in the molten bath in which metallic aluminum is made by electrolysis. For more detailed discussion see references (2), and (6).

Marketing. Quotations, Eng. and Min. Jour., Metal and Mineral Markets, July 1945: "Fluorspar: On and after August 30, 1943, the maximum price f. o. b. a consumer's plant shall be \$30 per short ton, plus freight, provided, however, that on a sale or delivery to which W. P. B. has certified that higher grades are required, the maximum price shall be computed by using the applicable price set forth in the table. Acid grade, base price, 97.5 percent Ca F_2 , \$37 per ton, plus freight."

Possible Buyers. E. I. du Pont de Nemours & Co., Inc., (The R. & H. Chemicals Department), Wilmington, Del.; Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.; Chas. W. Garland Co., 412 W. Sixth St., Los Angeles, Calif.; General Chemical Co., 40 Rector St., New York, N. Y.; Industrial Minerals & Chemical Co., 6th & Gilman St., Berkeley, Calif.; International Selling Corp., 67 Broad St., New York, N. Y.; The McGean Chemical Co., 1106 Republic Bldg., Cleveland, Ohio; Mercantile Import & Export Corp., 21 East 40th St., New York, N. Y.; Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.; Strategic Materials Corp., 210 W. 7th St., Los Angeles, Calif.

SELECTED REFERENCES

For more complete discussion, the following references, some of which give extensive bibliographies, have been selected.

1. Burchard, E. F., Fluorspar Deposits in Western United States: Am. Inst. Min. Met. Eng. Trans. Vol. 109, pp. 370-393, 1934. Bibl.
2. Ladoo, R. B., Fluorspar. Its Mining, Milling and Utilization with a chapter on cryolite: U. S. Bur. Mines. Bull. 244, pp. 180, 1927. Comprehensive, with extensive bibliography.
3. Ore deposits of the Western States (Lindgren volume), Fluorite. Amer. Inst. Min. Met. Eng. 1933.
4. Pabst, Adolf. Minerals of California: Calif. State Div. Mines, Bull. 113, 1941. A brief description of occurrences.
5. Ries, H., Fluorspar. Economic Geology, 7th Ed. John Wiley and Sons Inc., pp. 269-275, 1937. Brief description, bibliography.
6. Minerals Yearbook. Fluorspar: U. S. Bur. Mines. Annual publication presenting a record of development and trends in the mineral industry, with statistical details. Chapter on fluorspar each year.

CURRENT LITERATURE

Fluorine and its Compounds: Chemical and Metallurgical Engineering; Industrial and Engineering Chemistry; Journal of the American Chemical Society; Journal of Physical Chemistry.

NOTE.—Books, Government publications and some current literature containing information on fluorite minerals may be consulted at the California State Division of Mines, Ferry Building, San Francisco. Specimens of these minerals, and of the rocks in which they occur may also be seen in the mineral exhibit of the Division.

LIBRARY

LIBRARY REPORT

By JAMES M. LITTLE*

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INTRODUCTION

The library of the Division of Mines contains more than 6,000 selected volumes on mines, mining, and allied subjects. It is also the repository for reports and bulletins of technical departments of Federal and State governments and educational institutions both domestic and foreign. Current copies of newspapers published in the mining centers of the State are also available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY AND UNITED STATES BUREAU OF MINES

The library of the Division of Mines has available for public reference the following publications of the United States Geological Survey: Annual Reports, Monographs, Professional Papers, Bulletins, Water-Supply Papers, Mineral Resources, Folios of the Geologic Atlas of the United States (broken file), Maps with Descriptive Text (broken file), Administrative Publications (broken file); and the following publications of the United States Bureau of Mines: Bulletins, Technical Papers, Economic Papers (broken file), Mineral Resources of the United States, Monographs (broken file), Reports of Investigations, Information Circulars.

PUBLICATIONS OF STATE SURVEYS

A broken file of mining and geological publications, issued by the organizations listed below, may be consulted in the library of the Division of Mines.

Alabama Geological Survey, University.
Alaska (Territorial Commissioner of Mines), Juneau.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Indiana Division of Geology, Indianapolis.
Iowa Geological Survey, Des Moines.

* Librarian, Division of Mines.

State Geological Survey of Kansas, Lawrence.
 Kentucky Geological Survey, Frankfort.
 Louisiana Department of Conservation, New Orleans.
 Maine State Geologist, Augusta.
 Maryland Geological Survey, Baltimore.
 Michigan Geological Survey, Lansing.
 Minnesota Geological Survey, Minneapolis.
 Mississippi State Geological Survey, University.
 Missouri Bureau of Geology and Mines, Rolla.
 Montana Bureau of Mines and Geology, Butte.
 Nebraska Geological Survey, Lincoln.
 Nevada State Bureau of Mines, Reno.
 New Jersey Department of Conservation and Development, Trenton.
 New Mexico Bureau of Mines and Mineral Resources, Socorro.
 New York Science Division, Albany.
 North Carolina Geological and Economic Survey, Chapel Hill.
 North Dakota Geological Survey, Grand Forks.
 Ohio Geological Survey, Columbus.
 Oklahoma Geological Survey, Norman.
 Oregon State Department of Geology and Mineral Industries, Portland.
 Pennsylvania Topographic and Geological Survey, Harrisburg.
 South Dakota State Geological Survey, Vermillion.
 Tennessee Division of Geology, Nashville.
 Texas Bureau of Economic Geology, Austin.
 Virginia Geological Survey, University.
 Washington State Department of Conservation and Development, Pullman.
 West Virginia Geological Survey, Morgantown.
 Wisconsin Geological and Natural History Survey, Madison.
 Wyoming Geological Survey, Cheyenne.

PUBLICATIONS OF FOREIGN GOVERNMENTS

Publications of the following foreign governments are received and current issues may be consulted in the library. Earlier issues of foreign-language publications have been loaned to the California Academy of Sciences in Golden Gate Park, because of the limited storage space at the Division's offices in the Ferry Building. They may, however, be consulted at the Academy.

Alberta Research Council, Edmonton.
 Argentina Direccion General de Minas y Geologica, Buenos Aires.
 British Columbia Minister of Mines, Victoria.
 British Museum of Natural History, London.
 Canada Department of Mines, Ottawa.
 Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
 Geological Service of Minas Geraes, Bella Horizonte, Brazil.
 Geological Survey of Scotland.
 Instituto Historica e Geographico, Rio de Janeiro.
 Museo de Historia Natural de Montevideo, Uruguay.
 New South Wales Department of Mines, Sydney, Australia.
 New Zealand Geological Survey Branch, Wellington.
 Nova Scotia Department of Public Works and Mines, Halifax.
 Ontario Department of Mines, Toronto, Canada.
 Quebec Bureau of Mines, Quebec.
 Queensland Department of Mines, Brisbane, Australia.
 South Australia Department of Mines, Adelaide.
 Transvaal Chamber of Mines, Johannesburg, South Africa.
 Western Australia Geological Survey, Perth.

PUBLICATIONS OF FOREIGN AND DOMESTIC SOCIETIES AND EDUCATIONAL INSTITUTIONS

Academia de Ciencias y Artes de Barcelona, Spain.
 Academy of Natural Sciences of Philadelphia.
 American Association of Petroleum Geologists, Tulsa, Oklahoma.
 American Geographical Society of New York.
 American Institute of Mining and Metallurgical Engineers, New York.
 American Journal of Science, New Haven, Conn.
 American Philosophical Society, Philadelphia.
 Australian Museum, Sydney.
 California Academy of Sciences, San Francisco.
 Canadian Institute of Mining and Metallurgy, Montreal.
 Carnegie Institution of Washington.
 Cleveland Museum of Natural History, Cleveland, Ohio.
 Colorado College Publications, Colorado Springs.
 Colorado Scientific Society, Denver.
 Commonwealth Club, San Francisco.
 Economic Geology, Lancaster, Pa.

Field Museum of Natural History, Chicago.
 Franklin Institute of the State of Pennsylvania, Lancaster.
 Geological Society of America, Columbia University, New York.
 Geographical Society of London.
 Institution of Mining and Metallurgy, London.
 Instituto Geologico de Mexico, Mexico, D. F.
 Journal of Geology, Chicago.
 Mineralogical Society of America, Menasha, Wisconsin.
 Michigan College of Mining and Technology, Houghton.
 Mining and Metallurgical Society of America, New York.
 Missouri School of Mines and Metallurgy, Rolla.
 Museu Nacional, Rio de Janeiro.
 National Research Council, Washington, D. C.
 New York Academy of Sciences, New York.
 New York State Museum, Albany.
 Pennsylvania State College, State College.
 Philippine Journal of Science, Manila.
 Royal Society of South Australia, Adelaide.
 Seismological Society of America, Stanford University.
 Sierra club, San Francisco.
 Society of Economic Paleontologists and Mineralogists, Tulsa, Oklahoma.
 Southern California Academy of Sciences, Los Angeles.
 Stanford University, Palo Alto, California.
 University of California Publications in Engineering, Geography, and Geology, Berkeley.
 University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

CURRENT MAGAZINES

Current issues of the technical magazines listed below are on file in the reading room of the library, and may be consulted.

Published in

CALIFORNIA

Auburn

California Mining Journal—monthly.

Bakersfield

Mineral Notes News (Cal. Fed. of Min. Societies)—monthly.

Los Angeles

California Oil World—twice monthly.

California Safety News—monthly.

Grizzly Bear (Native Sons and Native Daughters of the Golden West)—monthly.

Petroleum World—monthly.

Southwest Builder and Contractor—monthly.

Sacramento

California Highways and Public Works.

San Francisco

California Fish and Game (State Division of Fish and Game)—quarterly.

California Magazine of the Pacific (State Chamber of Commerce)—monthly.

Mining and Industrial News—monthly.

Pacific Road Builder and Engineering Review—monthly.

Pacific Purchaser—monthly.

Standard Oil Bulletin—quarterly.

Whittier

Fusion Facts (Stoody Company)—quarterly.

ARIZONA

Phoenix

The Mining Journal—twice monthly.

Pay Dirt—monthly.

COLORADO

Golden

The Mines Magazine (Colorado School of Mines)—monthly.

DELAWARE

Wilmington

Hercules Mixer—monthly.

ILLINOIS*Chicago*

Brick and Clay Record—monthly.
Light Metal Age—monthly.
Rock Products—monthly.

NEW YORK*New York*

Chemical and Metallurgical Engineering—monthly.
Civil Engineering—monthly.
Engineering and Mining Journal—monthly.
Lubrication (The Texas Company)—monthly.
Mining and Metallurgy (A. I. M. & M. E.)—monthly.
Nickel Steel Topics—monthly.
Oil, Paint and Drug Reporter—weekly.
Scientific American—monthly.

OKLAHOMA*Tulsa*

Independent Monthly (Petroleum Association of America).
Oil and Gas Journal—weekly.

PENNSYLVANIA*Eaton*

Civil Engineering—monthly.

Philadelphia

Asbestos—monthly.
Chemical Industries—monthly.

York

Engineering and Mining Journal—monthly.

TEXAS*Houston*

Oil Weekly.

UTAH*Salt Lake City*

Mining and Contracting Review—twice monthly.

WASHINGTON*Seattle*

Mining World—monthly.

WASHINGTON, D. C.

Mining Congress Journal—monthly.

WISCONSIN*Milwaukee*

The Driller—monthly.

Foreign**CANADA***Gardenvale*

Canadian Mining Journal—monthly.

AUSTRALIA*Melbourne*

Chemical Engineering and Mining Review—monthly.

ENGLAND*London*

The Gemmologist—monthly.

NEWSPAPERS

Current issues of the following papers are received and kept on file in the library :

*Published in***CALIFORNIA**

Angels Camp: Calaveras, California.
Auburn: Placer Herald.
Barstow: Barstow Printers Review.
Bishop: Inyo Register.
Colfax: Colfax Record.
Crescent City: Del Norte Triplicate.
Downieville: Mountain Messenger.
Grass Valley: The Union.
Independence: Inyo Independent.
Jackson: Amador Dispatch.
Los Angeles: Los Angeles Times—Monday only.
Mariposa: Mariposa Gazette.
Needles: Needles Nugget.
Nevada City: Nevada City Nugget.
Palo Alto: Palo Alto Citizen.
Placerville: Placerville Times.
Quincy: Feather River Bulletin and Plumas Independent.
Randsburg: Randsburg Times.
San Andreas: Calaveras Prospect.
San Francisco: Daily Commercial News and S. F. Municipal Review.
Sonora: The Banner.
 Tuolumne Independent.
 Union Democrat.
Tuolumne: Tuolumne Prospector.
Terra Bella: Terra Bella News.
Weaverville: Weekly Trinity Journal.
Yreka: Yreka Journal.

ARIZONA

Kingman: Mojave Miner.

COLORADO

Denver: Denver Mining Record.

GEORGIA

Atlanta: Outdoor Georgia.

NEVADA

Las Vegas: Las Vegas Age.
Reno: Mining Press.

WASHINGTON

Seattle: Alaska Weekly.

SERVICES OF THE DIVISION OF MINES

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January 1922, and continued until March 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September 1923. For the same reason, beginning with the January 1924 issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January 1933 chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

TYPES OF REPORTS

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

Reports of District Mining Engineers

In 1919-1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the frontispiece outline map of the State.

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

Special Articles

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

MAIL AND FILES

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

COMMERCIAL MINERAL NOTES

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial

minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of *Commercial Mineral Notes*, and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco 11; State Building, Los Angeles 12; State Office Building No. 1, Sacramento 14; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

Write for latest revised price list.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

Price
(including
postage and
sales tax)

**Report I of the State Mineralogist, 1880, 43 pp.	Henry G. Hanks	-----	
**Report II of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map.	Henry G. Hanks	-----	
**Report III of the State Mineralogist, 1883, 111 pp., 21 illustrations.	Henry G. Hanks	-----	
**Report IV of the State Mineralogist, 1884, 410 pp., 7 illustrations.	Henry G. Hanks	-----	
**Report V of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map.	Henry G. Hanks	-----	
**Report VI of the State Mineralogist, Part 1, 1886, 145 pp., 3 illustrations, 1 map.	Henry G. Hanks	-----	
Part II, 1887, 222 pp., 36 illustrations.	William Irelan, Jr.	-----	
	Price \$0.75, sales tax \$0.02		\$0.77
**Report VII of the State Mineralogist, 1887, 315 pp.	William Irelan, Jr.	-----	
**Report VIII of the State Mineralogist, 1888, 948 pp., 122 illustrations.	William Irelan, Jr.	-----	
Report IX of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps.	William Irelan, Jr.	-----	
	Price \$1.15, sales tax \$0.03		1.18
**Report X of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps.	William Irelan, Jr.	-----	
Report XI (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps.	William Irelan, Jr.	-----	
	Price \$1.50, sales tax \$0.04		1.54
**Report XII (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps.	J. J. Crawford	-----	
**Report XIII (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map.	J. J. Crawford	-----	
Chapters of the State Mineralogist's Report XIV, Biennial Period, 1913-1914, Fletcher Hamilton:			
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper		-----	
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	Price \$0.50, sales tax \$0.01		.51
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	Price \$0.35, sales tax \$0.01		.36
Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	Price \$0.75, sales tax \$0.02		.77
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	Price \$0.50, sales tax \$0.01		.51
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper		-----	
**Report XIV of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915:		-----	
A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth			
Chapters of the State Mineralogist's Report XV, Biennial Period, 1915-1916, Fletcher Hamilton:			

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties , 176 pp., paper -----	
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties , 91 pp., paper -----	Price \$0.50, sales tax \$0.01 \$0.51
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties , 198 pp., paper -----	
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties , 183 pp., paper -----	
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties , 136 pp., paper -----	
**Mines and Mineral Resources, San Bernardino and Tulare Counties , 186 pp., paper -----	
**Report XV of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties , 990 pp., 413 illustrations, cloth -----	
Chapters of the State Mineralogist's Report XVI , Biennial Period, 1917-1918, Fletcher Hamilton:	
**Mines and Mineral Resources of Nevada County , 270 pp., paper -----	
Mines and Mineral Resources of Plumas County , 188 pp., paper -----	Price \$0.50, sales tax \$0.01 .51
Mines and Mineral Resources of Sierra County , 144 pp., paper -----	Price \$0.75, sales tax \$0.02 .77
Report XVII of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth -----	Price \$2.50, sales tax \$0.06 2.56
Report XVIII of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, April, May, June, July, August, September, October, November, December, 1922 -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XIX of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XX of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy -----	Price \$0.30, sales tax \$0.01 .31
Chapters of Report XXI of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly: January, 1925. Mines and Mineral Resources of Sacramento, Monterey and Orange Counties -----	Price \$0.30, sales tax \$0.01 .31
April, 1925. Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties -----	Price \$0.30, sales tax \$0.01 .31
**July, 1925. Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties -----	
**October, 1925. Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties -----	
Chapters of Report XXII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926. Mines and Mineral Resources of Trinity and Santa Cruz Counties -----	
**April, 1926. Mines and Mineral Resources of Shasta, San Benito and Imperial Counties -----	
July, 1926. Mines and Mineral Resources of Marin and Sonoma Counties -----	Price \$0.30, sales tax \$0.01 .31
**October, 1926. Mines and Mineral Resources of El Dorado and Inyo Counties , also report on Minaret District, Madera County -----	

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
Chapters of Report XXIII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927. Mines and Mineral Resources of Contra Costa County ; Santa Catalina Island -----	Price \$0.30, sales tax \$0.01 .31
April, 1927. Mines and Mineral Resources of Amador and Solano Counties Price \$0.30, sales tax \$0.01	.31
**July, 1927. Mines and Mineral Resources of Placer and Los Angeles Counties -----	---
October, 1927. Mines and Mineral Resources of Mono County -----	---
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXIV of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928. Mines and Mineral Resources of Tuolumne County -----	---
Price \$0.30, sales tax \$0.01	.31
April, 1928. Mines and Mineral Resources of Mariposa County -----	---
Price \$0.30, sales tax \$0.01	.31
**July, 1928. Mines and Mineral Resources of Butte and Tehama Counties -----	---
October, 1928. Mines and Mineral Resources of Plumas and Madera Counties -----	---
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXV of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
**January, 1929. Mines and Mineral Resources of Lassen, Modoc and Kern Counties ; also on Special Placer Machines -----	---
**April, 1929. Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties -----	---
July, 1929. Mines and Mineral Resources of Colusa, Fresno and Lake Counties -----	---
Price \$0.30, sales tax \$0.01	.31
October, 1929. Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties -----	---
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXVI of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1930. Mines and Mineral Resources of Santa Clara County ; also Barite in California -----	---
Price \$0.40, sales tax \$0.01	.41
**April, 1930. Mines and Mineral Resources of Nevada County ; also Mineral Paint Materials in California -----	---
**July, 1930. Mines and Mineral Resources of Yuba and San Bernardino Counties ; also Commercial Grinding Plants in California -----	---
October, 1930. Mines and Mineral Resources of Butte, Kings and Tulare Counties ; also Geology of Southwestern Mono County (Preliminary) Price \$0.40, sales tax \$0.01	.41
Chapters of Report XXVII of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931. Preliminary Report of Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline talc. Decorative effects in Concrete -----	---
Price \$0.40, sales tax \$0.01	.41
April, 1931. Stratigraphy of the Kreyenhagen Shale. Diatoms and Sili- coflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyen- hagen Shale. Geology of Santa Cruz Island -----	---
Price \$0.40, sales tax \$0.01	.41
**July, 1931. (Yuba, San Bernardino Counties.) Feldspar, Silica, Anda- lusite and Cyanite Deposits of California. Note on a Deposit of Anda- lusite in Mono County ; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining -----	---
October, 1931. (Alpine County.) Geology of the San Jacinto Quad- rangle south of San Geronio Pass, California. Notes on Mining Activ- ities in Inyo and Mono Counties in July, 1931 -----	---
Price \$0.40, sales tax \$0.01	.41
Chapters of Report XXVIII of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	

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		Price (including postage and sales tax)
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January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite-----	Price \$0.40, sales tax \$0.01	\$0.41
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining-----		----
**Abstract from April quarterly; Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)-----		----
**July-October, 1932. (Ventura County). Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville Shasta Succession of California. Geology of a part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist-----		----
Chapters of Report XXIX, 1933 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
**January-April, 1933. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic map showing various mines and prospects of part of Del Norte and Siskiyou Counties-----		----
July-October, 1933. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming, Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543-----	Price \$1.00, sales tax \$0.03	1.03
Chapters of Report XXX, 1934 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
January, 1934. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits-----	Price \$0.60, sales tax \$0.02	.62
April-July, 1934. Elementary Placer Mining in California and Notes on the Milling of Gold Ores-----	Price \$1.00, sales tax \$0.03	1.03
October, 1934. Current Mining Developments in Northern California. Current Mining Activity in Southern California. Geology and Mineral Resources of the Julian District, San Diego County. Geology and Mineral Resources of Elizabeth Lake Quadrangle, Dry Placers of Northern Mojave Desert. Biennial Report of State Mineralogist. Assessment Work Within Withdrawn Areas-----	Price \$0.60, sales tax \$0.02	.62
Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
January, 1935. Review of Gold Mining in East-Central California, 1934. Current Mining Activities in the San Francisco District with Special Reference to Gold. Geological Investigation of the Clays of Riverside and Orange Counties, Southern California. Information regarding Mining Loans by the Reconstruction Finance Corporation--	Price \$0.60, sales tax \$0.02	.62

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April, 1935. A Geologic Section Across the Southern Peninsular Range of California. New Technique Applicable to the Study of Placers. Grubstakes Permits-----	Price \$0.60, sales tax \$0.02	\$0.62
July, 1935. Mines and Mineral Resources of Siskiyou County (with map). Dams for Hydraulic Mining Debris. Leasing System as Applied to Metal Mining. Mine Financing in California. New Laws Make Radical Change in Mining Rights-----	Price \$0.60, sales tax \$0.02	.62
October, 1935. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County-----	Price \$0.60, sales tax \$0.02	.62
Chapters of Report XXXII, 1936 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
January, 1936. Gold Mines of Placer County, including Drag-line Dredges Geologic Report on Borax Lake, California-----	Price \$0.60, sales tax \$0.02	.62
April, 1936. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum-----	Price \$0.60, sales tax \$0.02	.62
July, 1936. Mines and Mineral Resources of Calaveras County. Mining in California by Power Shovel. Assessment Work on Mining Claims Within Withdrawn Areas. Joshua Tree National Monument. Cost of Producing Quicksilver at a California Mine in 1931-1932. The Age of Mineral Utilization-----	Price \$0.60, sales tax \$0.02	.62
October, 1936. Mineral Resources of Lassen and Modoc Counties. Mechanics of Lone Mountain Landslides, San Francisco. Biennial Report of the State Mineralogist, Properties and Industrial applications of Opaline Silica-----	Price \$0.60, sales tax \$0.02	.62
Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
January, 1937. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold-----	Price \$0.60, sales tax \$0.02	.62
April, 1937. Mineral Resources of Plumas County (with Geologic Map). List of preferred mineral names. New Placer Mining Debris Law.-----	Price \$0.60, sales tax \$0.02	.62
July, 1937. Mineral Resources of Los Angeles County (with map showing principal Mines and Oil Fields). Geology and mineral deposits of the Western San Gabriel Mountains, Los Angeles County-----	Price \$0.60, sales tax \$0.02	.62
October, 1937. Mineral Resources of the Resting Springs Region, Inyo County. Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California. Native Arsenic from Grass Valley, California-----	Price \$0.60, sales tax \$0.02	.62
Chapters of Report XXXIV, 1938 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:		
**January, 1938. Mineral Development and Mining Activity in Southern California during the year 1937. Doing Something About Earth-quakes. Gold and Petroleum in California. Gem Minerals of California, Lapidary Art-----		
April, 1938. Gold dredging in Shasta, Siskiyou and Trinity Counties; Geology of the Central Santa Monica Mountains; Marketing Mica-----	Price \$0.60, sales tax \$0.02	.62
July, 1938. El Dorado County, Mineral High-Lights of California; Strategic Minerals of California; Cyanide Treatment of Gossan at Mountain Copper Co.; Submarine Canyons off the California Coast.-----	Price \$0.60, sales tax \$0.02	.62

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October, 1938. Inyo County, Biennial Report of State Mineralogist, Sulphur Deposits of Inyo County, Geology of the Darwin Silver-Lead Mining District -----	Price \$0.60, sales tax \$0.02	\$0.62
Chapters of Report XXXV, 1939 (quarterly) titled "California Journal of Mines and Geology," containing the following:		
January, 1939. San Diego County, Geology and Oil Possibilities of Southwestern San Diego Co.; Prospect for 'Minor Metals' and Nonmetallic Minerals; The Right to Mine-----	Price \$0.60, sales tax \$0.02	.62
April, 1939. Shasta County, Public's Interest in Mine Taxation-----	Price \$0.60, sales tax \$0.02	.62
July, 1939. Tertiary Formations of Northern Sacramento Valley, California; Geology and Oil Possibilities of Caliente Range, Cuyama Valley and Carrizo Plain, California; Bibliography of the Geology and Mineral Resources of California for the year 1937; The Giant Goose Lake Meteorite from Modoc County, California-----	Price \$0.60, sales tax \$0.02	.62
**October, 1939. Quicksilver Resources of California; Sulphate Minerals of the Leviathan Sulphur Mine, Alpine County, California-----		----
Quicksilver Resources of California. Reprint--	Price \$0.50, sales tax \$0.01	.51
Chapters of Report XXXVI, 1940 (quarterly) titled "California Journal of Mines and Geology," containing the following:		
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	Price \$0.15, sales tax \$0.01	\$0.16
**Register of Mines, with Map, Shasta County	-----	
**Register of Mines, with Map, Sierra County	-----	
**Register of Mines, with Map, Siskiyou County	-----	
**Register of Mines, with Map, Trinity County	-----	
**Register of Mines, with Map, Tuolumne County	-----	
Register of Mines, with Map, Yuba County (1905)	-----	
	Price \$0.15, sales tax \$0.01	.16
**Register of Oil Wells, with Map, Los Angeles City (1906)	-----	

Other Maps

**Map of California, Showing Mineral Deposits (50x60 in.)	-----	
**Map of Forest Reserves in California	-----	
**Mineral and Relief Map of California	-----	
**Map of El Dorado County, Showing Boundaries, National Forests	-----	
**Map of Madera County, Showing Boundaries, National Forests	-----	
**Map of Placer County, Showing Boundaries, National Forests	-----	
**Map of Sierra County, Showing Boundaries, National Forests	-----	
**Map of Siskiyou County, Showing Boundaries, National Forests	-----	
**Map of Tuolumne County, Showing Boundaries, National Forests	-----	
**Map of Mother Lode Region	-----	
**Map of Desert Region of Southern California	-----	
Map of Minaret District, Madera County	-----	Price .10
Map of Copper Deposits in California	-----	Free
**Map of Calaveras County	-----	
**Map of Plumas County	-----	
**Map of Trinity County	-----	
**Map of Tuolumne County	-----	
**Geographical Map of Inyo County. Scale 1 inch equals 4 miles	-----	
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	-----	
**Geologic Map of California, 1916. Scale 1 inch equals 12 miles. Shows railroads, highways, post offices and other towns. Geological details lithographed in 23 colors. Mounted	-----	
**Unmounted	-----	
Geologic Map of California, 1938. Scale 8 miles per inch. Lithographed in 80 distinguishing colors and patterns showing geologic units. In 6 sections, each 32 in. x 42 in. Set of 6 sheets, unmounted. Sheets not sold separately	-----	Price \$4.00, sales tax \$0.10 4.10
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92. In 4 colors (also sold singly)	-----	

Other Maps—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
{Map of Ancient Channel System, Calaveras County-----	
{Map of Ancient Channels Between San Andreas and Mokelumne Hill-----	
Price for set of 2 maps \$0.25, sales tax \$0.01	\$0.26
Commercial Minerals of California, chart of-----	Free
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt accompanying July-October, 1932, Chapter of Report XXVIII of the State Mineralogist. (Sold singly)-----	
Price \$0.25, sales tax \$0.01	.26
Map of Northern California, showing rivers and creeks which produced placer gold in 1932-----	
Price \$0.15, sales tax \$0.01	.16
Redding and Weaverville Quadrangle Geologic Map and the Northwestern Part of the Red Bluff Quadrangle, showing location of gold mines. (Accompanying January-April, 1933, Chapter of Report XXXIX), sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Mother Lode, Geologic-----	Price .10
Mother Lode Maps showing Geology and Mining Claims in Amador, Calaveras, El Dorado, Mariposa, and Tuolumne Counties, accompanying Bulletin 108, 5 maps, sold separately, each-----	
Price \$0.15, sales tax \$0.01	.16
Geologic Map of Elizabeth Lake Quadrangle, Los Angeles and Kern Counties (accompanying October, 1934, Chapter of Report XXX), sold separately-----	
Price	.10
Mariposa Co. Map, accompanying report on Mines and Minerals of Mariposa Co. in January, 1935, Chapter of Report XXXI, sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Map of Western Portion of Siskiyou County Showing Location of Principal Gold Mines (accompanying July, 1935, Chapter of Report XXXI), sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Perris Block Map (accompanying Oct., 1935, Chapter of Report XXXI), sold separately-----	
Price	.10
Plumas Co. Map, accompanying Report on Mines and Mineral Resources of Plumas Co. in April, 1937, Chapter of Report XXXIII, sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Los Angeles County Map, accompanying report on mines and mineral resources of Los Angeles County, in July, 1937, Chapter of Report XXXIII, sold separately-----	
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El Dorado Co. Map, accompanying report on Mines and Minerals of El Dorado Co. in July, 1938, Chapter of Report XXXIV, sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Santa Monica Mts., Western Geologic Map of-----	Price .10
Inyo Co. Map, accompanying report on Mines and Minerals of Inyo Co., in October, 1938, Chapter of Report XXXIV, sold separately-----	
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San Diego Co., Map, accompanying Report on Mines and Mineral Resources of San Diego Co. in January, 1939, Chapter of Report XXXV, sold separately-----	
Price \$0.15, sales tax \$0.01	.16
Shasta Co. Map, showing mines, accompanying Report on Mines and Mineral Resources of Shasta Co. in April, 1939, Chapter of Report XXXV, sold separately-----	
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Quicksilver deposits, sold in conjunction with October, 1939, Chapter of Report XXXV-----	
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Mono County Map, accompanying report on mines and mineral resources of Mono County in April, 1940, Chapter of Report XXXVI, sold separately-----	
Price	.10
Kernville Quadrangle Geologic Map, accompanying report on mines and mineral resources of Kern Quadrangle in October, 1940, Chapter of Report XXXVI, sold separately-----	
Price	.10
Trinity County, Showing Locations of Principal Mineral Deposits (accompanying January, 1941, Chapter of Report XXXVII)-----	
Price \$0.15, sales tax \$0.01	.16

Other Maps—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
Chromite deposits (showing California geology uncolored)-----	
Price \$0.60, sales tax \$0.02	\$0.62
Grass Valley and Nevada City District claim map accompanying report on mines and mineral resources of Nevada Co. in July, 1941, Chapter of Report XXXVII, sold separately-----	Price .10
Nevada City District Claim Map , accompanying report on mines and mineral resources of Nevada County in July, 1941, Chapter of Report XXXVII, sold separately-----	Price .10
Nevada County Map , accompanying report on mines and mineral resources of Nevada County in July, 1941, Chapter of Report XXXVII, sold separately-----	Price \$0.15, sales tax \$0.01 .16
Oil and Gas Fields (showing California geology uncolored), accompanying Bulletin 118, sold separately-----	Price \$1.00, sales tax \$0.03 1.03
Index map of Economic Minerals and Geomorphic Provinces -----	Free
Imperial Co. Map , accompanying report on mines and mineral resources of Imperial County in April, 1942, Chapter of Report XXXVIII, sold separately-----	Price .10
Tungsten Properties in California, accompanying July-October, 1942, Chapter of Report XXXVIII (showing California geology uncolored), sold separately-----	Price \$0.60, sales tax \$0.02 .62
Santa Cruz Co. Map , accompanying report on mines and mineral resources of Santa Cruz County in January, 1943, Chapter of Report XXXIX, sold separately-----	Price \$0.15, sales tax \$0.01 .16
San Benito Quadrangle Geologic Map , accompanying report on geology of area in April, 1943, Chapter of Report XXXIX, sold separately Price \$0.40, sales tax \$0.01	.41
San Bernardino County Map , accompanying report on mines and mineral resources of San Bernardino County in October, 1943, Chapter of Report XXXIX, sold separately-----	Price \$0.15, sales tax \$0.01 .16
Manganese Deposits (showing California geology uncolored), accompany- ing Bulletin 125, sold separately-----	Price \$0.60, sales tax \$0.02 .62

OIL AND GAS FIELD MAPS

The following maps are on sale at the State Division of Oil and Gas, Ferry Building, San Francisco, and the various branch offices. The maps are revised as development work advances and ownerships change. Price includes postage and sales tax.

No.	Price
1—Sargent, Santa Clara County-----	\$0.75
2—Santa Maria, including Cat Canyon—Los Alamos, Santa Barbara County-----	1.25
3—Santa Maria, including Casmalia and Lompoc, Santa Barbara County--	1.25
4—Brea Olinda and East Coyote, Los Angeles, Orange Counties-----	1.25
6—Salt Lake—Beverly Hills, Los Angeles County-----	1.25
7—Sunset, including San Emidio, Kern County-----	1.25
8—South Midway, including Buena Vista Hills, Kern County-----	1.25
9—North Midway and McKittrick, Kern and San Luis Obispo Counties-----	1.25
10—South Belridge and McKittrick-Temblor oil fields, Kern County-----	1.25
11—Lost Hills and North Belridge, including Antelope Hills, Kern County---	1.25
12—Devils Den, Kern County-----	1.00
13—Kern River and Kern Front fields, including portion of Poso Creek field, Kern County-----	1.00
14—Coalinga and East Coalinga Extension, Fresno County-----	1.50
15—Elk Hills, Kern County-----	1.25
16—Ventura-Ojai, Ventura County-----	1.25
17—Santa Paula-Ojai, including South Mountain, Ventura County-----	1.25
18—Sespe-Piru-Simi, including Bardsdale, Ventura County-----	1.50
18a—Newhall, Aliso Canyon, Newhall-Potrero, Del Valle and Oak Canyon, Los Angeles County-----	1.25
19—Arroyo Grande, San Luis Obispo County-----	1.00

OIL AND GAS FIELD MAPS—Continued

No.	Price
20—Long Beach, Los Angeles County-----	\$1.75
21B—District 5, boundaries of areas including oil fields, Fresno, Kings and Kern Counties-----	1.00
21C—District 4, boundaries of areas including oil fields, Kern, Kings and Tulare Counties-----	1.25
22—District 3, boundaries of areas including oil fields, Santa Barbara County-----	.75
23—District 2, boundaries of areas including oil fields, Ventura County-----	1.00
24—District 1, boundaries of areas including oil fields, Los Angeles and Orange Counties-----	1.00
26—Huntington Beach, Orange County-----	1.50
27—Santa Fe Springs, Los Angeles County-----	1.25
28—Torrance, Los Angeles County-----	1.25
28a—Townlot area, Torrance field, Los Angeles County-----	.75
29—Dominguez, Los Angeles County-----	1.00
30—Rosecrans, Los Angeles County-----	1.25
31—Inglewood, Los Angeles County-----	1.25
32—Seal Beach, Los Angeles and Orange Counties-----	1.25
33—Rincon, Ventura County-----	1.50
34—Mt. Poso and Poso Creek, Kern County-----	1.00
35—Round Mountain, Kern County-----	1.00
36—Kettleman North Dome and Middle Dome, Fresno and Kings Counties--	1.50
37—Montebello, Los Angeles County-----	1.00
38—Whittier, Los Angeles County-----	1.25
39—West Coyote Oil Field, Los Angeles and Orange Counties-----	1.25
40—Elwood, Goleta (abandoned), La Goleta (gas), Santa Barbara County--	1.25
41—Potrero, Los Angeles County-----	1.00
42—Playa del Rey, Los Angeles County-----	1.50
43—Capitan, Santa Barbara County-----	1.00
44—Mesa, Santa Barbara County-----	1.50
46—Richfield, Orange County-----	1.25
48—Mountain View and Edison, Kern County-----	1.25
49—Fruitvale, Kern County-----	1.00
50—Wilmington, Los Angeles County-----	1.25
51—Santa Maria Valley, Santa Barbara County-----	1.00
52—El Segundo and Lawndale, Los Angeles County-----	1.50
53—Rio Bravo and Greeley, Kern County-----	1.00
54—Wasco oil field, Buttonwillow and Semitropic (gas), Kern County-----	1.25
55—Canal, Canfield Ranch, Coles Levee, Strand, Ten Section, Kern County--	1.25
56—Paloma, Kern County-----	1.25
57—Rio Vista (gas), Sacramento, Solano, and Contra Costa Counties-----	1.00
58—Trico Gas, Kern, Kings and Tulare Counties-----	1.00
59—Raisin City, Helm and Riverdale, including Wheatville area, Fresno County-----	1.25

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY

State Mineralogist

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CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY



QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XLI

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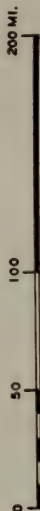
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CALIFORNIA

AND THE

DISTRICTS OF THE DIVISION OF MINES

SCALE

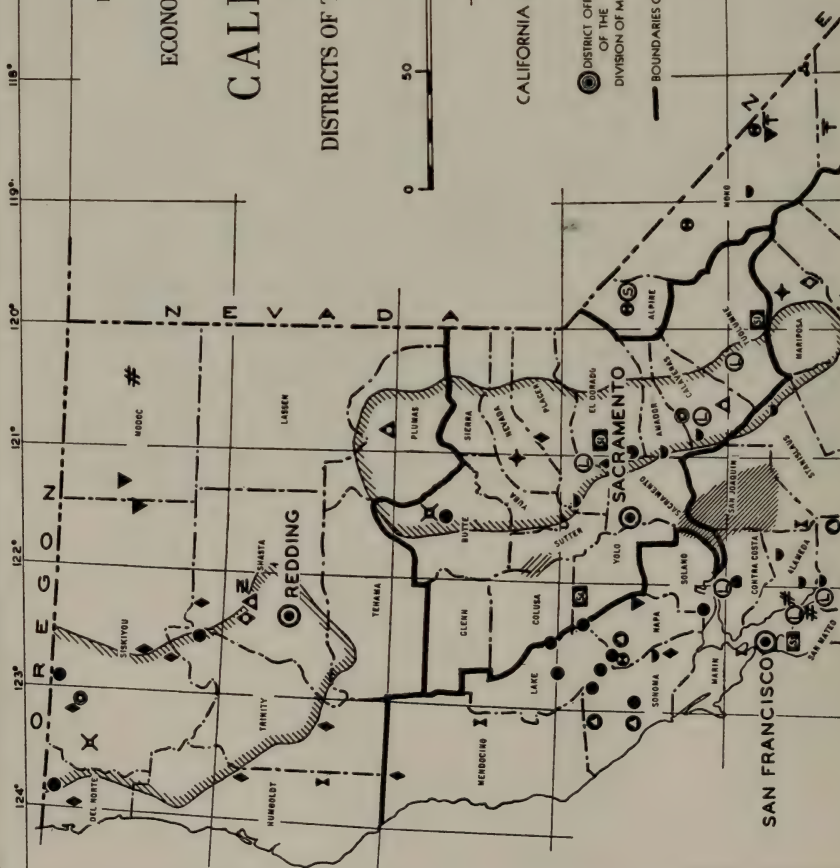


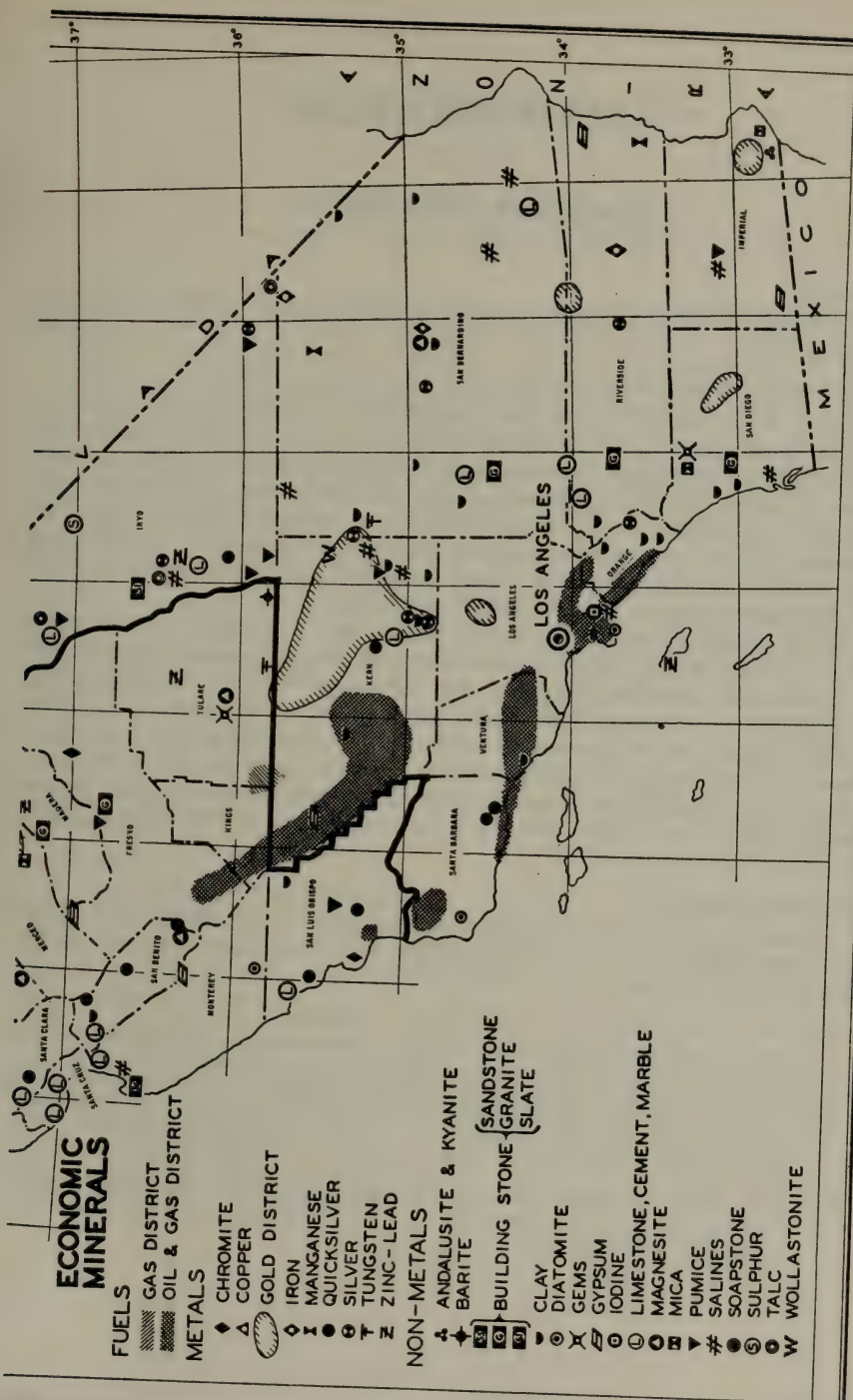
CALIFORNIA STATE DIVISION OF MINES

1943

DISTRICT OFFICES
OF THE
DIVISION OF MINES
(San Francisco (main office)
Los Angeles
Sacramento
Redding)

BOUNDARIES OF THE DISTRICTS





ECONOMIC MINERALS

FUELS

- GAS DISTRICT
- OIL & GAS DISTRICT

METALS

- CHROMITE
- COPPER
- GOLD DISTRICT
- IRON
- MANGANESE
- QUICKSILVER
- SILVER
- TUNGSTEN
- ZINC-LEAD

NON-METALS

- ANDALUSITE & KYANITE
- BARITE
- BUILDING STONE
- SANDSTONE
- GRANITE
- SLATE
- CLAY
- DIATOMITE
- GEMS
- GYPSUM
- IODINE
- LIMESTONE, CEMENT, MARBLE
- MAGNESITE
- MICA
- PUMICE
- SALINES
- SOAPSTONE
- SULPHUR
- TALC
- WOLLASTONITE

ADMINISTRATION

ADMINISTRATIVE REPORT

By WALTER W. BRADLEY, STATE MINERALOGIST

Personnel

There have been no changes in personnel to be noted during the past three months.

New Almaden Mine Centennial

On November 17th, at San Jose, with a luncheon at the Sainte Claire Hotel, the California Pioneers of Santa Clara County celebrated the 100th anniversary of the opening, November 20, 1845, of the famous New Almaden quicksilver mine by Andres Castillero, a Mexican army officer. Dr. Milton H. Shutes of Oakland, a writer of several works on Abraham Lincoln, told of the early history of the mine, the litigation which involved the title, and of the part that the Civil War President played in the controversy over the property.

The State Mineralogist was present as a guest of honor, and informed the group that the total value of New Almaden's production of quicksilver over the 100 years has been greater than the total yield of the State's richest single gold mine. The production from New Almaden has been surpassed by only one mine in the world (Almaden mine, Spain) during the period in which New Almaden has been operating. The Idria mine, Austria, and the Santa Barbara mine, Huanavelica, Peru, have also exceeded it in production, but the bulk of their yield was made prior to 1850.

New Publications

Since last noted, the following publications of the Division of Mines have been received from the State Printer, and are now available at the offices of the Division:

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

January 1945, being Chapter 1 of State Mineralogist's Report XLI. This chapter contains: *Administrative Report*, including *Obituary Note on Dr. Joseph A. Jeffery*; *Current Notes*, Geologic Branch; *Quicksilver Deposits of Central San Benito and Northwestern Fresno Counties*; *War-Time Mineral Industry of California*; *Accessions to the Mineral Exhibit*; *Review of California Mineral Production for 1944*; *Additions to Bulletin 113*.

GEOLOGIC MAP OF THE JAMESBURG QUADRANGLE, Monterey County, to accompany the April 1944 chapter of California Journal of Mines and Geology, has been received from the engraver.

GEOLOGIC BRANCH

CURRENT NOTES

By OLAF P. JENKINS *

In this Issue

The results of the Federal Survey's strategic minerals investigations are now being published by the State Division of Mines. The results of work on the Pine Creek and Adamson tungsten mines of Inyo County appear in this issue of the Journal. The author, Paul Bateman, is stationed at Bishop, California, and it is planned that his geologic work will proceed along the eastern front of the Sierra Nevada and will represent a part of the cooperative program which is now under way between the State Division of Mines and the U. S. Geological Survey.

The Geologic Branch of the Division of Mines has prepared for this issue of the JOURNAL a complete index of all topographic quadrangles of the State of California. It should serve as a basis for planning topographic mapping in the State. An extensive program of topographic mapping is now under way as a cooperative project between the State Division of Water Resources and the U. S. Geological Survey. Topographic maps are the basis for all geologic work and are therefore fundamental and vital to any developmental program of the mineral industry. Libraries and departments of geology and engineering should find this index useful because it takes stock of the published maps, and it should serve as a form on which maps published in the future may be recorded.

In Preparation

Bulletin 129, *Iron Resources of California*. Advance chapters of part of this Bulletin will soon be available.

Geologic report and geologic map of the San Juan Bautista quadrangle will appear as Bulletin 133 instead of in the January 1946 Journal, as announced previously.

Forthcoming Publications

Geology and Mineralization of the Julian-Cuyamaca Area Near Julian, San Diego County by S. C. Creasey.

Geology of Santa Rosa Peak Area, Riverside County, California by Lawrence B. Wright.

* Chief Geologist, Division of Mines.

PINE CREEK AND ADAMSON TUNGSTEN MINES INYO COUNTY, CALIFORNIA *

BY PAUL C. BATEMAN **

U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

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ABSTRACT

The Pine Creek mine contains the largest known reserve of tungsten ore in the United States, estimated at 968,000 tons of measured ore containing 687,000 units of WO_3 (tungsten trioxide); 1,026,000 tons of indicated ore containing 733,000 units; and 568,000 tons of inferred ore containing 419,000 units—a total of 2,562,000 tons containing 1,839,000 units.

The mine has been worked intermittently since 1916. Between 1938 and October 1944, when it was operated by the U. S. Vanadium Corporation, it was one of the principal domestic producers of tungsten. Important amounts of molybdenum and lesser amounts of copper were also recovered. Since October 1, 1944 mining operations have been suspended, but mine development has been continued.

The adjacent Adamson mine has reserves estimated at 38,800 tons of indicated ore containing 30,600 units of WO_3 and 12,000 tons of inferred ore containing 13,000 units. The total production, amounting to 38,609 tons of ore from which 18,109 units of WO_3 were recovered, was made in 1942 and 1943 by Panaminas Inc.

The mines are near the crest of the Sierra Nevada in Inyo County, California, at elevations ranging from 10,750 to 12,800 feet. A surfaced road extends 20 miles from Bishop to the U. S. Vanadium Corporation's 1500-ton mill in Pine Creek, and a dirt road leads from the mill 7 miles to the Pine Creek mine and 9 miles to the Adamson mine.

The mines are near the north end and on the west side of the Pine Creek pendant in a contact zone between marble and intrusive granite and quartz diorite. The contact zone consists mainly of garnet-diopside tectite, but includes quartz and quartz-

* Published by permission of the Director, Geological Survey, U. S. Department of the Interior. On August 1, 1945 a copy of this report and the accompanying maps were placed in the Geological Survey open file, at the office of the Geologic Branch, Division of Mines, Ferry Building, San Francisco. Manuscript revised for publication September 20, 1945; received by Division of Mines October 1, 1945.

** Associate Geologist, Geological Survey, U. S. Department of the Interior.

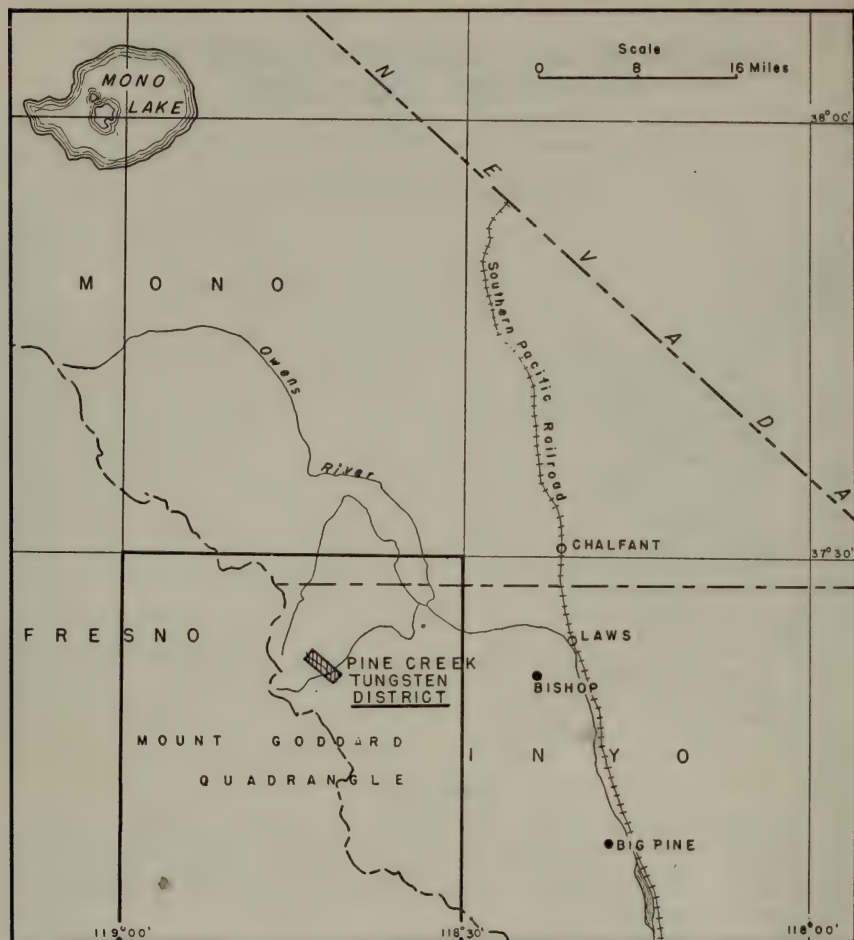


FIG. 1. Index map showing location of Pine Creek tungsten district, Inyo County, California.

feldspar rocks. Thicker portions of the contact zone constitute the orebodies. Five orebodies crop out in the area of the Pine Creek mine and two on the Adamson property. All of them contain tungsten in commercial amounts, but only the North and the South orebodies of the Pine Creek mine contain molybdenum in important quantities.

Scheelite (CaWO_4), the only tungsten mineral of this area, and molybdenite (MoS_2) and secondary powellite (CaMoO_4), the molybdenum minerals, occur within the orebodies in well-defined ore shoots that are only partly co-extensive. The tungsten ore shoots are surprisingly continuous, especially in their vertical dimensions. They are restricted to the tactite, of which they comprise, on the average, less than half. The molybdenum shoots are smaller and less extensive than the tungsten shoots; and although they occur in both tactite and the quartzose rocks, are more closely related to the latter. No information is available concerning the distribution of the copper minerals in the orebodies; but the primary sulfides, chalcopyrite and bornite, appear to be closely associated with molybdenite.

All of the constituents of the contact zone are thought to have been deposited from solutions that worked upward along permeable zones developed by fracturing between marble and the solidified crust of cooling granite. The solutions deposited minerals, with some overlap, in the following succession: diopside and garnet, scheelite, quartz and feldspar, quartz, quartz and molybdenite, and quartz. Localization of tungsten and molybdenum ore shoots is believed to have been controlled by fracturing.

INTRODUCTION

The Pine Creek mine, operated by the U. S. Vanadium Corporation, contains the largest known reserve of tungsten ore in the United States, approximately 2,500,000 tons with an average content of 0.7 percent WO_3 (tungsten trioxide). From 1938 to 1944 it was one of the principal domestic sources of tungsten, and it also supplied important amounts of molybdenum and lesser amounts of copper. The adjacent Adamson mine made a much smaller production of the same metals in 1942 and 1943, when it was operated by Panaminas, Inc.

The mines are situated in rugged, glaciated country near the crest of the Sierra Nevada in Inyo County, California (Mount Goddard quadrangle). They are on a branch of Morgan Creek, a tributary to Pine Creek, an eastward-flowing stream that empties into the Owens River near the town of Bishop. The Pine Creek mine is at elevations between 10,750 and 11,700 feet; workings on the Adamson property range from 11,500 to 12,800 feet in elevation. A surfaced road extends from Bishop to the U. S. Vanadium Corporation's 1500-ton mill at the junction of Pine and Morgan Creeks (only the old mill, now dismantled, is shown on plate 36). From the mill, at an elevation of 7,700 feet, a dirt road leads 7 miles to the Pine Creek mine and 9 miles to the Adamson mine. Ore is moved from the Pine Creek mine to the mill by an aerial tramway with a capacity of about 100 tons per hour.

The Pine Creek deposit was discovered in 1916. It was operated by the Pine Creek Tungsten Company from 1917 to 1919, by the Tungsten Products Company from 1922 to 1926, and by the U. S. Vanadium Corporation since 1936. Total production to the end of 1944 (table 1) amounted to 586,834 units of WO_3 (tungsten trioxide) and 2,655,281 pounds of molybdenum.

The amount of ore mined during 1942 and 1943 averaged about 1,200 tons daily, nearly a third of which was from 3 open cuts. After exhaustion of these cuts in the latter part of 1943, all production came from underground workings. Mining operations were suspended on October 1, 1944 because of shortage of manpower, but mine development work has been continued.

The Pine Creek mine is developed by means of four main levels, known as levels 250, A, C, and E, at elevations of 10,540, 10,790, 11,070, and 11,370 feet, and by numerous sublevels, raises, and stopes. In August 1944 the main levels amounted to 14,400 feet of drifts and cross-cuts, the sublevels to 8,000 feet. Work on a low level adit (Zero level), designed to intersect the orebodies 1,500 feet beneath the present workings, was begun in August 1944. The portal of this adit, at an elevation of 9,251 feet, is 6,000 feet south of the southernmost known orebody, the South orebody.

The Adamson mine adjoins the Pine Creek mine on the north and is on the same geologic structure. Operations were discontinued in 1944 because of high costs, an inadequate supply of labor, and termination by the Metals Reserve Company of its contracts to purchase tungsten concentrates. The total production in 1942 and 1943 of 38,609 tons of ore was sold to the Metals Reserve Company and treated in the U. S. Vanadium mill where 18,109 units of WO_3 were recovered.

Workings in the Adamson mine are much less extensive than those in the Pine Creek mine. Level workings total 2,000 feet and are limited to the Northwest orebody and to the contacts between granite and marble 600 to 1,000 feet southeast of that orebody (pl. 47). The Ridge orebody, 1,000 feet higher at an elevation of 12,800 feet, is developed only by means of open cuts. In 1943, a jig-back aerial tramway connected the Ridge orebody with a bin near the Northwest orebody.

The data for this report were assembled from several sources. A topographic and geologic map of the surface (pl. 36) prepared by D. M. Lemmon of the Survey in 1939 and 1940 was revised slightly. Detailed maps of the Pine Creek mine made in August and September 1942 by Lemmon and the writer were brought up to date by the writer and M. P. Erickson during two weeks in August 1944. The writer and Erickson also prepared maps of the Adamson mine in August 1943, and revised them in September 1944.

The U. S. Vanadium Corporation supplied surveys of the mine levels and stopes in the Pine Creek mine, geological information on inaccessible parts of the mine (in particular, level 250, which was under water), and comprehensive assay data. Plate 37, the surface map showing the Pine Creek orebodies on a scale of 200 feet to 1 inch, is a reduction from maps on a scale of 40 feet to 1 inch prepared by the mine staff of the U. S. Vanadium Corporation. Panaminas, Inc., supplied surveys of the underground workings on the Adamson property and considerable assay data.

Most of the geological data for the general part of this report are based on observations made in the Pine Creek mine. The Adamson mine is much smaller and less well developed and does not offer comparable opportunities for geologic study.

GEOLOGY

The mines are near the north end and on the west side of the Pine Creek pendant, an elongate block of metamorphic rocks bounded on all sides by intrusive granite and quartz diorite. The pendant is about $5\frac{1}{2}$ miles long and 1 mile wide, extending from Mt. Tom on the south across Pine Creek to Wheeler Ridge on the north. It is composed principally of hornfels, schist, and quartzite, but also contains marble for $3\frac{1}{2}$ miles on the west side. All of the orebodies except the Ridge orebody are in the contact zone between this marble and granite. The depth to which the pendant extends is unknown, but there is no indication of granite encroaching even in the deepest workings.

In Pine Creek Canyon, the beds are folded into a tight syncline. This structure probably continues northward into the mine area, but there the folding is tighter and the beds dip vertically or steeply to the east or west, and strike parallel to the north trend of the pendant.

The granite is later in age and more extensive than the quartz diorite, with which it is genetically related. It is a light-colored, even-grained rock containing biotite as the only dark mineral. A typical specimen examined by Lemmon¹ contained 58 percent of orthoclase and microcline,

¹ Lemmon, Dwight M., Tungsten deposits in the Sierra Nevada near Bishop, California: U. S. Geol. Survey Bull. 931-E, pp. 83-84, 1941.

18 percent of oligoclase, 5 percent of biotite, and 1 percent of accessories (including zircon, sphene, apatite, and pyrite). The quartz diorite is darker and is composed of 67 percent of oligoclase, 11 percent of quartz, 11 percent of hornblende, 10 percent of biotite, and 1 percent of accessories (zircon, sphene, pyrite, and apatite). Aplite dikes are abundant in the granite and diorite where they lie along flat joints, but few occur in the metamorphic rocks.

Elongate bodies of quartz diorite crop out between granite and the pendant southward from the South orebody, but both the surface exposures and those in underground workings at the south end of Level A in the Pine Creek mine (pl. 39) indicate that the quartz diorite bodies are cut out at depth by granite. No orebodies have been found along this part of the contact.

In much of the mine area, the contact between granite and the pendant probably follows a pre-intrusive fault that guided the emplacement of the granite. For a distance of 3,000 feet north from the prominent granite re-entrant between the North and South orebodies (pl. 36), the contact is remarkably straight and cuts across bedding in the marble at a small angle. South of this re-entrant and on line with the straight part of the contact, the marble within the pendant is silicified and contains considerable pyrite.

To the south, the re-entrant becomes increasingly elongated at depth and on Level A extends 1200 feet farther south than at the surface (pl. 39). At this level, both the re-entrant and the contact of the main body of granite with the pendant, where explored in the long crosscut, are on line with the postulated fault.

Faulting is further strongly suggested by the anomalous stratigraphic position of a sliver of hornfels, half a mile long and completely enclosed in marble. This body of hornfels is south of the limits of plate 36 but still in line with the straight part of the contact at the surface north of the granite re-entrant. Because of steep slopes much of this hornfels is inaccessible, but where it can be reached the beds along its margins are considerably contorted. Pre-intrusive faulting might also explain the stratigraphic displacement of the hornfels contained in the elongate block of metamorphic rocks explored by the 1300-main adit on the Adamson property. It is not entirely certain that this block is connected with the main pendant at its south end, for intervening areas are covered by talus.

The trace of the contact north of the North orebody across extremely rugged topography is straight and indicates a vertical dip; in the workings of the Pine Creek mine the contact dips vertically or very steeply to the west. In the North orebody (pl. 45) the contact and the bedding are parallel and local irregularities are few. In the proximity of the Level E orebodies, however, where the beds dip 75° E. and are truncated by the granite, granite sills penetrate along bedding planes downward and away from the main contact (pl. 46). The local influence of bedding on the emplacement of the granite is also shown on the level maps of the North orebody.

The contact zone consists of garnet-diopside tectite, and quartz and quartz-feldspar rocks. The garnet-diopside tectite, which makes up the larger part of the contact zone, is a medium- to fine-grained rock consisting essentially of garnet and diopside with small amounts of sheelite,

molybdenite, and other sulfides, including chalcopyrite, bornite, and pyrite. The quartz and quartz-feldspar rocks frequently contain molybdenite, but no scheelite.

The quartzose rocks mapped as a unit include, in addition to quartz and quartz-feldspar rock, the more quartzose portions of the tactite. Most of the quartz in the tactite occurs in veinlets, but some of it is an integral part of the tactite. Because the amount of quartz in the tactite is variable, the separation of a quartzose portion is somewhat arbitrary.

The age relations of the various contact rocks are not entirely clear, but it is thought that both the quartz and quartz-feldspar rocks are younger than the tactite. The quartz in stringers was unquestionably the last to be formed.

Detritus-filled solution channels, locally called "sand streaks", are well developed in the marble adjacent to the North and South orebodies and in horses of marble within the North orebody. Individual channels range from a few inches to several feet in width, extend as much as 200 feet along the strike, and, in the North orebody, can be traced from the surface down to 150 feet below Level A (pl. 45). A few large, unfilled cavities have been found (notably in the Pine Creek mine on Level A at 6380 N., 5600 E.), but most are filled with stratified granitic sand and with coarser fragments of granite, limestone, and contact rock. The stratification is usually steep, and ranges from horizontal to vertical. The dips are presumably initial, and steep ones may have resulted from deposition in narrow crevices simultaneously with solution of the limestone. Within some of the detrital fillings there are slickensided surfaces caused by slight slippage along minor faults.

Numerous post-mineral faults that strike northeasterly and dip steeply occur between the main tactite masses and near their extremities. The gouge along these faults was thickened by alteration of the wall rock resulting from downward percolation of surface waters along the fault planes. In the underground workings of the Pine Creek mine the greatest displacements observed were only a few feet. The faults are obscured at the surface by talus, but to the east along the contact between marble and hornfels there are no noticeable offsets. The faults apparently represent minor adjustments between the rigid tactite masses.

OREBODIES

General Features

Five orebodies crop out in the area of the Pine Creek mine and two on the Adamson property (pls. 36, 37, 47). All of them contain tungsten in commercial amounts, but only the North and South orebodies of the Pine Creek mine contain molybdenum in substantial quantities. Molybdenum is present in minor amounts in the other orebodies and is recovered as a by-product. Copper also is a valuable by-product.

Scheelite (CaWO_4), the only tungsten mineral, and molybdenite (MoS_2) and secondary powellite (CaMoO_4), the molybdenum minerals, occur within the orebodies in well-defined ore shoots that are only partly co-extensive. The distribution of these shoots was determined by a study of assay data furnished by the U. S. Vanadium Corporation and by Panaminas, Inc. The general positions of the shoots are, for the most part,

fixed by the assay data, but details of the boundaries can only be deduced from a study of the habits of the mineralization. The interpretations of the writer are shown on the accompanying illustrations. Ore shoots are not shown in the South orebody on the surface map (pl. 37), and on the upper part of the block diagram (pl. 43), where they are known to be present, because assay data are not available.

Tungsten Ore Shoots

The tungsten ore shoots are surprisingly continuous, especially in their vertical dimensions. This is particularly evident in the North orebody where individual shoots can be identified from level to level (pls. 39 to 41; pl. 45). The tungsten ore shoots are restricted to the tactite, of which they comprise less than half, on the average, and only about one-third in the North orebody. The shoots are sufficiently large and persistent, both laterally and in depth, to be stoped individually.

The grade of ore treated at the U. S. Vanadium Corporation mill during the three-year period 1942-44 averaged about 0.45% WO_3 , but this grade represents a mixture of ore from the tungsten shoots containing 0.7% WO_3 with barren or very low-grade material, some of which, however, contained substantial quantities of molybdenite. Ore from the Adamson mine contained an average of 0.57% WO_3 , but this also represents a mixture of higher grade ore and low-grade material. The tungsten ore shoots shown on the illustrations are areas in which few or no assays fall below 0.4% WO_3 . The average of 959 assays from tungsten shoots in the Pine Creek mine, not including diamond drill samples, is 0.70% WO_3 . Diamond drill samples from the tungsten shoots average somewhat higher, 0.79% WO_3 for 115 assays (see table 2 for statistical data). In contrast, the tactite in the orebodies exclusive of the tungsten shoots and quartz and quartz-feldspar rock contains an average of 0.24% WO_3 . The tungsten shoots outlined by assay values have reasonably sharp limits, and are not bordered by large tonnages of marginal grade ore.

Molybdenum Ore Shoots

The molybdenum shoots are more limited in their distribution than the tungsten ore shoots, are of substantially higher grade, have more erratic, and less sharply defined boundaries, and, although they occur in both tactite and the quartzose rocks, are more closely related to the latter. The largest known molybdenum shoot is in the North orebody. In the South orebody molybdenum is present in the outcrop, and on Level C, but little or no molybdenum occurs on Level A. Very little molybdenum is present in the Level E orebodies. Flakes of molybdenite and powellite are scattered through the other orebodies, but there are no concentrations comparable to those in the North orebody or the upper part of the South orebody.

Molybdenum assays are recorded in percentage of sulfide (MoS_2), but a substantial portion of the molybdenum is actually present in the ore either in powellite, the pure molybdate formed as an alteration product of molybdenite, or in scheelite, which frequently contains a small amount of molybdenum. No accurate information is available to the writer as to the relative abundance of the two minerals in the ores. Approximately ten percent of the molybdenum recovered in the mill is derived from molybdenum-bearing scheelite. Very little is recovered

from pure powellite. The ore treated in recent years has averaged about 0.45% MoS₂.

In the ore shoots plotted on the maps and sections, ore with a cutoff grade of 0.7% MoS₂ is distinguished from ore of lower grade with a cutoff of 0.4% MoS₂. Assays of 721 samples from shoots of both grades in the North orebody, excluding samples from diamond drill holes give an average of 0.95% MoS₂. As in the case of tungsten, the diamond drill assays average substantially higher, 1.14% for 59 assays (see table 3 for statistical data). The contact rock, including both taectite and quartzose rocks, exclusive of the molybdenum shoots, contains only about 0.20% MoS₂.

The tungsten and molybdenum shoots in the North orebody are only about 25 percent co-extensive. Ore from the west stopes in the North orebody and from the small stope above Level A at 5850 N., although it contained tungsten, was mined primarily for its molybdenum content.

Copper Mineralization

The ore treated at the U. S. Vanadium Corporation mill contains from 0.20 to 0.25% copper. Chalcopyrite and bornite occur in the ore, but no information is available concerning the distribution of these minerals in the orebodies. A substantial proportion of the copper is present as carbonate.

Orebodies in the Pine Creek Mine

South Orebody

The South orebody is at the tip and west edge of a marble wedge separated from the North orebody by a granite re-entrant. On the surface the orebody is 300 feet long and 150 feet wide. In the underground workings the length is the same, but the maximum width diminishes downward to 75 feet on Level C and 50 feet on Level A. Two diamond drill holes that intersected the orebody 125 and 570 feet beneath Level A suggest, respectively, thicknesses of 14 and 15 feet of ore (pl. 43). The orebody dips steeply east and rakes 60° south. Both dip and rake are controlled by the granite, the former by the attitude of the granite contact on the west, the latter by the pitch of the granite trough enclosing the north end of the orebody.

A single tungsten shoot extends through the south part of the orebody from the surface down to the deepest diamond drill hole. The north part of the orebody contains little or no tungsten. Twenty-eight samples from within the tungsten shoot on Level A contained 0.90% WO₃. Considerable molybdenite can be seen in the glory hole at the surface, but no assays are available. Only a single, small, low-grade molybdenum shoot occurs on Level C and none on Level A. Apparently a large molybdenum shoot occurred at the surface, but pinched out rapidly downward.

The orebody and the tungsten shoot will probably continue downward for some distance below Level A, perhaps to the level of the Zero adit; but decrease in the width of the marble downward suggests that the marble wedge, and consequently the orebody, will be cut off by granite at a moderate depth.

North Orebody

The North orebody is the largest and most extensively explored in either the Pine Creek or Adamson mines. It averages 600 feet long and

100 feet thick, and extends from the surface downward at least 1,400 feet to the intersection with the deepest diamond drill hole below Level 250. The east side of the orebody is concordant with bedding in the marble. The orebody thickens southward as the marble beds diverge from the granite contact, and the south end fingers out into marble.

The orebody is thicker beneath two overhanging steps in the granite, one between Levels A 3 and A 5, and one between Level C 7 and the surface (pl. 45). Above Level C 7, both the width and length decrease and the area of the outcrop is little more than half the average area of the orebody in the underground workings.

The orebody dips steeply and rakes vertically with minor irregularities. It extends farther to the north between Levels A 5 and C 4 than it does above Level C 4 or below Level A 5 (pl. 45). The south end of the orebody on Level 250 is slightly north of its position on Level A, possibly because of a north rake, because of downward pinching, or because of local irregularity.

A wedge of quartzose rocks projects from the step in the granite between Levels A 3 and A 5 downward to the Grizzly level and splits the orebody longitudinally. The bulk of this mass is quartz-feldspar rock, but it is cut by numerous quartz veinlets, many of which continue into the surrounding tectite. Much quartz extends upward from this wedge, especially along the granite wall of the contact zone. On Level C 7 many quartz veins containing substantial amounts of molybdenite occur in the granite adjacent to the contact. The granite near the veins is silicified. A drill hole on Level A 5 cored similar molybdenum-bearing quartz veins.

A single tungsten ore shoot extends from the surface to Level C, where it splits into a north and a south shoot, both of which continue downward east of the quartzose wedge. At Level A 1, with the downward termination of the quartzose wedge, these shoots begin to grow smaller and to merge with small irregular shoots in the west part of the orebody. Below Level A in the plane of section 6270 (pl. 45), a single tungsten shoot lies adjacent to the granite through the west portion of the orebody, but in section 6400 (pl. 45), there appear to be two shoots, separated by an intervening barren zone.

The average of 737 assays of muck samples from the tungsten shoots is 0.66% WO_3 . Diamond drill samples average somewhat higher, 0.76% WO_3 for 82 assays. Between Levels C 4 and A, the average content of WO_3 in the ore shoots decreases downward proportionally as the shoots increase in size. This relation between size and grade is such that the total tungsten content is approximately the same at each level.

The largest shoot of molybdenum ore known in either the Pine Creek or Adamson mines is in the North orebody, extending from Level A to Level C 7 near the granite side of the orebody. The outcrop of the orebody was not sampled for molybdenum, so it is not known whether the ore shoot continues upward to the surface. Samples from a diamond drill hole bored upward from Level C 7, however, contained only small quantities of MoS_2 . Shoots containing 0.7% MoS_2 and more decrease in size and those containing 0.4% MoS_2 and more increase in size on Level A and the Grizzly level. Beneath Level A, no extensions of the molybdenum shoots have been encountered in any of the workings or diamond drill holes and it is possible that none exist.

The great vertical extent of the North orebody compared to its horizontal dimensions suggests that it occupies a main channel along which ore-bearing solutions rose. Probably both the orebody and the enclosed tungsten ore shoots will continue downward, perhaps to the bottom of the marble. Thickening of the orebody beneath the overhanging steps in the granite contact probably indicates that the steps acted as traps for the mineralizing solutions.

Pinnacle Orebody

The Pinnacle orebody extends along a pre-mineral fracture in marble. The ore-bearing solutions probably worked laterally from the North orebody along this fracture. On the surface the orebody contains a single tungsten shoot 160 feet long and averaging 25 feet in outcrop width. Twenty-six samples from this shoot contained an average of 0.62% WO_3 . The orebody was explored underground from Level C 7, several hundred feet beneath the outcrop, by means of 3 diamond drill holes, none of which encountered ore of commercial grade.

Level E Orebodies

The Level E orebodies are situated along a discordant part of the contact zone where the beds dip 75°E . The contact is irregular in detail with granite in places following the bedding, in places cutting across it. Granite also penetrates downward along bedding planes from the discordant parts of the contact (pl. 46).

Orebodies have been found from Level E to the surface, and from Level C for about 100 feet upward, in two distinct groups separated vertically by about 100 feet of barren contact. The upper group of orebodies, above Level E, is larger and contains more tungsten. The orebodies of the lower group lie beneath arches of granite and decrease in thickness downward.

Tungsten ore shoots occur in the upper parts of the orebodies, but the amount of scheelite decreases downward and the ore shoots finger out. Assays of 85 samples from the outcrops of the ore shoots contained 1.02% WO_3 , whereas 46 samples from Level E contained only 0.45% WO_3 . The molybdenum content is low, amounting to 0.15% MoS_2 in an average of samples from the surface and Level E, and to 0.21% MoS_2 in the small stope above Level C at 7950 N.

Other similar orebodies might be found along this part of the contact at greater depth, but it is unlikely that a large, continuous orebody will be found where the dip of the marble is discordant with the general dip of the contact.

Loop Orebody

The Loop orebody is situated between marble and granite that protrudes about 200 feet into the marble from the main line of the contact. The outcrop area of the orebody is 7,400 square feet, of which 6,800 square feet are included in a commercial-grade tungsten ore shoot. The average grade of 37 assays of samples from this shoot is 1.01% WO_3 .

Orebodies in the Adamson Mine

Northwest Orebody

The Northwest orebody, shaped in plan like a distorted horseshoe, is at the north end of an elongate block of marble and hornfels that is

split off from the main pendant. The orebody extends around and overlies the north end of the block, which is capped by granite. All the tactite is tungsten ore, and the thickest and richest portions are against the marble in the east limb of the orebody. Assays of 27 samples from different parts of the orebody gave an average of 0.59% WO_3 . The orebody has not been explored beneath the 1300-north adit, and all the ore has been stoped above this level. The sides of the mass of metamorphic rocks converge gradually downward, and the pendant will probably be cut off by granite in depth. The Northwest orebody may extend as deep as the marble, but it probably pinches out at a shallower point similar to the Level E orebodies, for the ore appears to have been accumulated beneath a granite cap.

The south end of the Northwest orebody is covered by talus and glacial till which obscure possible extensions. About 500 feet to the southeast, continuations of the metamorphic rocks are exposed extensively in the 1300-main adit where thin bands of scheelite-bearing tactite were followed for 400 feet without finding ore.

Ridge Orebody

The Ridge orebody is a tactite bed several hundred feet long and from 15 to 20 feet thick with hornfels on both sides. The total length of the part of the bed that carries scheelite in commercial amounts is not known, but Lemmon estimated that scheelite mineralization is present for 350 feet. Where the best ore is exposed on the ridge, samples taken at 10-foot intervals for a distance of 120 feet contained an average of 1.1% WO_3 . The only working is an open cut from which some ore was mined in 1943. There is no basis for estimating the depth to which ore may extend.

On the opposite slope and about 150 feet northeast of the Ridge orebody, a small mass of quartz-diopside rock, about 15 feet wide and 50 feet long, contains large, irregular pieces of scheelite as much as five inches across. The average grade of this rock is estimated to be from 2 to 5% WO_3 .

Genesis of the Orebodies

All the rocks and minerals of the contact zone are believed to have been deposited from solutions that worked upward along permeable zones developed by fracturing between marble and the already solidified crust of cooling granite. The solutions deposited minerals successively, but with some overlap, in the following order: diopside and garnet, scheelite, quartz and feldspar, quartz and molybdenite, and quartz. Although localization of the several stages of mineralization was probably controlled primarily by fracturing, the actual deposition of minerals involved chemical processes, including solution of the marble and reaction of marble and early formed minerals with the mineralizing solutions. The position of the copper in the mineral sequence is unknown because of scant information about the distribution of copper, but mineral associations suggest that the primary copper minerals are closely related to the molybdenite.

The relation of the irregularities in the granite contact to the shape and distribution of the orebodies indicates that the adjacent granite was already solidified when the contact zone was formed and that the mineralizing solutions had an upward path. The granite trough that

encloses the South orebody, for example, apparently guided the mineralizing solutions. The thick orebodies beneath granite cappings seem to have been accumulated in traps that could have been effective only on rising solutions in the North orebody, in the Level E orebody, and perhaps in the Northwest orebody. The great vertical extent of the North orebody and of its enclosed pipe-like tungsten shoots strongly suggests a vertical path for the solutions.

The several constituents of the contact zone are believed to be of slightly different ages. Some scheelite is distributed throughout the tactite, but the larger part is concentrated in sharply defined ore shoots which seem to have been formed later than the enclosing low-tungsten tactite. The quartz-feldspar rock is believed to have been introduced after the tungsten in ore shoots because of its close relationship to the late quartz stringers, although its exact position in the sequence is not definitely known. The quartz stringers cut all of the rocks of the contact zone. These stringers contain most of the molybdenite, but quartz apparently continued to be introduced after the molybdenum, for the latest quartz stringers contain no molybdenite.

Permeability produced by fracturing probably controlled distribution of the minerals in the contact zone, but the chemical activity that accompanied the deposition of the contact minerals has obscured much of the evidence. However, the quartz stringers, the last-formed constituents of the contact zone and those least dependent on chemical processes for their deposition, are quite apparently localized along small fractures. The Pinnacle orebody is the only convincing example of localization of an entire orebody along a fracture. The concordance between the east side of the North orebody and the bedding in the marble was probably caused by especial susceptibility of these beds to alteration; this susceptibility may have been chemical, textural, or the result of shearing along bedding.

Fracturing along the contacts of the granite with the pendant could have been caused by stresses arising from the emplacement or cooling of the granite. Such stresses would not have affected the contacts of the earlier quartz diorite with marble so strongly as those of the granite. This seems a reasonable explanation of the seeming preference of the orebodies for parts of the contact zone adjacent to granite as contrasted with the absence of orebodies from parts of the contact zone bordered by quartz diorite. Fracturing produced by regional stress would not account for this relationship.

The ultimate source of the ore solutions is presumed to have been the magma from which the granite, also, was derived, but it is apparent that the ore at any one place was not formed by solutions derived from the immediately adjacent granite. Evidence against such a process includes lack of correlation between the size of the orebodies and the bulk of the nearest granite, and ore traps and channels that indicate the mineralizing solutions worked up from below.

ORE RESERVES

Pine Creek Mine

The Pine Creek mine contains the largest reserve of tungsten ore known in the United States, estimated at 968,000 tons of measured ore containing 687,000 units of WO_3 ; 1,026,000 tons of indicated ore containing 733,000 units; and 568,000 tons of inferred ore containing 419,000

Table 1. *Production from the Pine Creek Mine, 1918-1944*

Operator	Year	Units WO ₃	Pounds Mo
Pine Creek Tungsten Co.-----	1918-19	1,736	-----
Tungsten Products Co.-----	1923	1,820	-----
	1925	8,000	-----
	1926	6,100	-----
	1927	532	-----
Herbert Sillinger-----	1933	67	-----
U. S. Vanadium Corp.-----	1937	975	-----
	1938	5,817	-----
	1939	20,526	-----
	1940	44,800	-----
	1941	86,907	168,170
	1942	172,864	836,768
	1943	150,832	943,999
	1944	85,867	706,344
		586,843	2,655,281

units—a total of 2,562,000 tons containing 1,839,000 units. The molybdenum reserve in the North orebody amounts to 512,000 tons of measured ore and 342,000 tons of indicated ore, a total of 854,000 tons that contain an average of 20 pounds of MoS₂ per ton. Inasmuch as molybdenum is recovered mainly as a by-product from tungsten, these reserve figures have only limited significance as regards future production. Probably from 3 to 5 pounds of MoS₂ will be recovered per ton of ore mined during the life of the mine, but the amount may be increased by discovery of additional molybdenum ore shoots. The reserves of tungsten and molybdenum ore contained in ore shoots are listed in tables 4 and 5. The estimates are based on measurements of the unstopped ore shoots at the surface and on mine levels (tables 2 and 3).

Tungsten Reserves

In the North orebody the tonnage of tungsten ore between levels was computed by averaging the areas in square feet of the tungsten ore shoots on the levels, multiplying this average by the vertical distance, and dividing the product by 10 (assuming 10 cubic feet per ton). Between Level A and the Grizzly level, allowance was made for the absence of stopes on Level A, although several stopes extend almost to that level.

Much of the measured tungsten ore remaining in the North orebody cannot be mined by present practices. The main minable reserve is above Level C 7. Probably only about 200,000 tons of the 791,000 tons between Level A and the surface can be mined. The reserve between Level A and Level 250 is divided into indicated and inferred ore. In computing indicated ore, it was assumed that only ore already explored is present on Level 250. In computing inferred ore, it was assumed that twice as much ore exists on Level 250 as has been explored. The ore between Level 250 and the drill hole 500 feet below is divided equally between indicated and inferred ore. The indicated ore extends from the explored ore on Level 250 downward to a point at the drill hole intersection. The inferred ore flanks this ore on both sides assuming that the area of ore at the level of the drill hole intersection is equal to the area of the explored ore on Level 250.

Table 2. Metamorphic rocks and tungsten ore shoots in the Pine Creek mine; areas and grade of samples in ore shoots

Area in square feet										Samples containing 0.4% WO ₃ or more			
Tactite	Quartzose rocks	Ore shoots containing 0.4% WO ₃ or more				Muck samples		Diamond drill samples					
		Stopes	Before stoping	Stoped	Remaining	Number	Percent WO ₃	Number	Percent WO ₃				
NORTH OREBODY													
18,700	No infor.	Glory hole	12,800	No infor.	No infor.	10	0.65						
32,300	Small	2,100	16,500	2,100	14,400			20	0.71				
45,900	Small	14,900	18,000	8,600	9,400	39	0.87						
Insufficient data						7	0.51						
51,000	Small	14,800	14,700	6,300	8,400	76	0.77	11	0.78				
45,400	1,700	3,700	14,700	1,200	13,500	71	0.73	2	0.64				
46,600	5,800	13,200	16,200	8,300	7,900	52	0.66	7	0.77				
47,000	9,200	25,000	17,900	10,500	7,400	24	0.79	7	0.90				
48,000	8,400	24,400	17,000	8,400	8,600	71	0.65	5	0.69				
44,700	4,700	21,400	17,700	8,600	9,100	114	0.66	11	0.74				
52,000	1,500	12,100	18,600	2,500	16,100	148	0.62	2	0.50				
56,100	Small	0	24,200	0	24,200	116	0.59	13	0.81				
Insufficient data						9	0.70	4	0.77				
SOUTH OREBODY										737	0.66	82	0.76
39,700	No infor.	Glory hole	No infor.	All	0								
15,200	0	Size unknown	9,800	All	0			1	0.99				
10,700	0	0	4,800	0	4,800	28	0.75						

Surface	27,900 17,500 31,500	LEVEL OREBODIES					No infor. 5,000 13,900	85 46	1.02 0.45	4 28	0.94 0.83
		Glory hole	16,000 5,000 13,900	No infor. 0 0							
E	2,000	0			LOOP OREBODY (8300 N)	6,800	No infor.	37	1.01		
C	0	0									
Surface	7,400	0	Glory hole	6,800	Small amt.						
	</										

The South orebody above Level A is almost exhausted. Some ore remains in pillars around Level C at 5900 N. and in the floor and the north wall of the glory hole. The reserve below Level A to the drill hole 580 feet lower is divided into indicated and inferred ore. The former extends from Level A downward to a point at the drill hole intersection. The latter is inferred from the probability that at least half as much ore exists at the level of the drill hole as on Level A.

In the Level E orebodies, the block between Level E and the surface is classed as measured ore, the ore at Level C as indicated. From the surface, the measured ore decreases downward both in tonnage and in grade, and appears to be almost at its lower limits on Level E. The indicated ore is assumed, arbitrarily, to extend 70 feet above and 70 feet below Level C.

In the Pinnacle and Loop orebodies, ore above the level of the lowest point of outcrop is classed as indicated, ore below this point as inferred. In the Pinnacle orebody the inferred ore extends half way to Level C 7, a distance of 106 feet; in the Loop orebody 130 feet, half way to Level E.

Table 4. Reserves of tungsten ore in the Pine Creek mine

	Measured		Indicated		Inferred	
	Tons	Units WO ₃	Tons	Units WO ₃	Tons	Units WO ₃
Loop orebody (8,300 N.)						
Above lowest outcrop			34,000	34,000		
Lowest outcrop to half the distance to Level E (130 feet vertically)					88,000	88,000
Level E orebody						
Surface to Level E	170,000	127,000				
Level C, 70 feet above to 70 feet below			195,000	136,000		
North orebody						
Surface to C 7	231,000	162,000				
C 7 to C 4	112,000	78,000				
C 4 to C	114,000	80,000				
C to A 5	39,000	28,000				
A 5 to A 4	40,000	28,000				
A 4 to A 3	30,000	21,000				
A 3 to A 2	26,000	18,000				
A 2 to A 1	27,000	19,000				
A 1 to Grizzly	44,000	31,000				
Grizzly to A	128,000	90,000				
A to 250			415,000	290,000	113,000	79,000
250 to drill hole 500 feet below			225,000	158,000	225,000	158,000
Pinnacle orebody						
Above lowest outcrop			18,000	11,000		
Lowest outcrop to half the distance to C 7 (106 feet vertically)					72,000	43,000
South orebody						
Pillars around level C	7,000	5,000				
Level A to drill hole 580 feet below			139,000	104,000	70,000	52,000
	968,000	687,000	1,026,000	733,000	568,000	420,000

Total 2,562,000 tons containing 1,840,000 units WO₃

Table 5. *Reserves of molybdenum ore in the North orebody*

	Independent of tungsten ore				Coextensive with tungsten ore			
	Measured		Indicated		Measured		Indicated	
	0.4% MoS ₂ or more	0.7% MoS ₂ or more	0.4% MoS ₂ or more	0.7% MoS ₂ or more	0.4% MoS ₂ or more	0.7% MoS ₂ or more	0.4% MoS ₂ or more	0.7% MoS ₂ or more
Surface to C 4-----			18,000	224,900				28,000
C 4 to C-----	7,000	109,000				15,000		
C to A 5-----	5,000	18,000			5,000	13,000		
A 5 to A 4-----	11,000	19,000			12,000	7,000		
A 4 to A 3-----	10,000	28,000			6,000	6,000		
A 3 to A 2-----	2,000	36,000			2,000	6,000		
A 2 to A 1-----	8,000	19,000			4,000	5,000		
A 1 to Grizzly-----	17,000	11,000			9,000	8,000		
Grizzly to A-----	27,000	43,000			19,000	25,000		
A to 30 feet below-----			18,000	26,000			15,000	13,000
	87,000	283,000	36,000	250,000	57,000	85,000	15,000	41,000

198,000 tons coextensive with tungsten ore.

656,000 tons independent of tungsten ore.

854,000 tons, average grade 1.0% MoS₂**Molybdenum Reserves**

A large part of the molybdenum recovered in the U. S. Vanadium Corporation mill is from tungsten ore that contains only small amounts of molybdenum. However, the calculated reserves include only ore contained in the molybdenum ore shoots. All of the reserves are in the North orebody, for the molybdenum ore shoots in the upper part of the South orebody are exhausted. The average grade of ore in the North orebody, including both plus 0.4% and plus 0.7% shoots, is about 1.0% MoS₂. Ore co-extensive with tungsten ore shoots is tabulated separately from ore independent of tungsten ore shoots (table 3).

The molybdenum reserves in the North orebody were computed by the same method as that used in calculating the tungsten reserves. It is doubtful if much of the measured ore between Levels A and C 4 can be mined by present practices. The main minable reserve is the indicated ore between Level C 4 and the surface and immediately beneath Level A. Recent exploration suggests that the ore shoots do not extend far beneath Level A.

Adamson Mine

The reserves in the Northwest orebody on the Adamson property lie beneath the 1300-north level, the ore above that level being exhausted. On the 1300-north level the ore covers an area of about 5,000 square feet and contains 0.59% WO₃ (average of 27 assays). If the grade and size of the orebody remain constant to a depth of 50 feet beneath the 1300-north level, there are 25,000 tons of indicated ore that contain 14,000 units of WO₃. Uncertainties as to factors that localized the orebody preclude calculation of reserves at greater depths.

The Ridge orebody has been shown by surface sampling to contain an average of 1.1% WO_3 for a length of 120 feet across an average width of 17 feet. Indicated ore, calculated to a depth of 60 feet beneath the outcrop, consists of 12,000 tons of ore that contain 13,000 units of WO_3 . An equal amount of inferred ore of the same grade lies beneath this ore to a depth of 120 feet below the outcrop.

The small high-grade mass of quartz-diopside rock east of the Ridge orebody contains at least 2.0% WO_3 . Indicated ore is estimated to a depth of 25 feet at 1,800 tons that contain 3,600 units of WO_3 .

All the orebodies contain molybdenum, but no data as to grade or distribution are available. No concentrations were observed comparable to the ore shoots in the North or South orebodies in the Pine Creek mine.

INDEX TO TOPOGRAPHIC QUADRANGLES OF CALIFORNIA

By MARY H. HELM *

WITH AN INTRODUCTION

By OLAF P. JENKINS **

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INTRODUCTION

As an outgrowth of studied plans for a state-wide program of mapping by the State Aerial Mapping Project Committee¹ the following lists and indexes to existing topographic quadrangles of California have been made. Included in the lists are U. S. Geological Survey topographic quadrangles; U. S. War Department topographic quadrangles;† U. S. Forest Service topographic sheets of the National Forests (not including planimetric maps of quadrangles); special topographic maps and river surveys of the U. S. Geological Survey; and names tentatively adopted by the U. S. Geological Survey for quadrangles yet to be mapped. Pertinent information has been assembled as to name of quadrangle, location, area covered, scale, contour interval, and publication agencies.

The following report is divided into four parts: (1) Complete alphabetical list (including tentatively adopted names of some areas which have not yet been mapped) of quadrangles and National Forest maps; (2) List of special maps, and river and damsite areas; (3) Index maps of California showing "unit-areas" arbitrarily numbered and lettered for quick finding, accompanied by a list of names of "standard", or 15-minute quadrangles; (4) Finding list of published topographic quadrangles, arranged by latitude and longitude.

* Geological Draftsman, Geologic Branch, State Division of Mines. Manuscript submitted for publication November 15, 1945.

** Chief Geologist, State Division of Mines.

¹See *Report and Recommendations to the State Reconstruction and Reemployment Commission by the State Aerial Mapping Project Committee, March 1945*. This program was implemented by Senate Bill 803, passed by the Legislature and signed by Governor Earl Warren in July 1945: "An Act to provide for basic topographic mapping of the State of California and making appropriation therefor." The bill calls for an appropriation of \$300,000, administered by the State Engineer, Department of Public Works, 5 percent of which is to be used for administrative purposes, but the balance of which is to be matched by Federal funds; the maps are to be produced by the Federal Government.

† Not included in these lists are the special maps made by the War Department along the coast of California. These include *Special Maps*, *Battle Maps*, and *Photo Maps* on the scale 1:20,000.

Planimetric maps (i.e., those that do not show contours) have been omitted. The U. S. Forest Service has issued a number of such maps covering 15-minute areas. The U. S. Coast and Geodetic Survey has published planimetric maps of the delta area and part of the southern coastal area; they have published small-scale aeronautical charts covering the whole State; and their coast charts are well known to all navigators; but none of these maps are included in the following list of topographic quadrangles.

In preparing these lists, the actual published maps have been examined, as well as various index maps issued from time to time by the U. S. Geological Survey, U. S. War Department, Army Map Service, U. S. Forest Service, and U. S. Coast and Geodetic Survey. Members of these organizations as well as many others, very kindly helped in checking the compilations.

Availability of the Maps

It must be understood that none of these maps are available from the State offices. In general, the maps are available from the agency that published them. It is hoped that eventually there will be established a Federal map-information center, where anyone may write for published quadrangles issued by any Federal agency.

OLAF P. JENKINS, Chief Geologist
November 23, 1945

ALPHABETICAL LIST OF TOPOGRAPHIC QUADRANGLES OF CALIFORNIA

Including Topographic Maps of National Forests, Some Special Maps, and
Tentative Names of Quadrangles Not Mapped as of November 1945

Explanation of Alphabetical List

COLUMN 1: *Name* of quadrangle, National Forest map, or special map; including proposed names for maps as yet (November 1945) unpublished. The latter are designated *Unpub.*

Compilation: Maps so designated have been compiled from various sources and do not represent original surveys.

Provisional: Maps so designated have been made by the U. S. Army Engineers by "blowing-up" smaller-scale maps; such maps cover parts of the desert region of southern California.

Reconnaissance: Maps so designated were made as an emergency measure, in most cases by the U. S. Army Engineers or, at an early date, by the U. S. Geological Survey; of reconnaissance quality only.

Tactical: Maps so designated were made by the U. S. Army Engineers, and show streams, culture, and vegetation, but very few contours.

See Special Maps: This statement occurs after the names of topographic maps of irregular shape, which do not fit into the general quadrangle index system. Information regarding these maps is given in the list of *Special Maps and River Surveys*.

COLUMN 2: *County* or counties in which the quadrangle lies.

COLUMN 3: *Map index numbers*: Two index systems are used (1) latitude-longitude index number (for example, N3652.5-W11930/7.5)

Relationship between area covered and scale of quadrangle

Map area (minutes)	Map scale	Linear scale
60	1:250,000	Approximately 1 in. = 4 miles
30	1:125,000	Approximately 1 in. = 2 miles
15	1: 62,500	Approximately 1 in. = 1 mile
7.5	1: 31,680	1 inch = $\frac{1}{2}$ mile
6	1: 24,000*	1 inch = 2,000 feet

giving the exact location of the southeast corner of the map, and exact area in minutes, from which the scale may be deduced; and (2) the unit-area index number (for example, C-8) for quick reference to a general area.

Example of latitude-longitude index number: The Academy quadrangle is indexed as N3652.5-W11930/7.5, because the point on the map nearest the equator and the Greenwich meridian is lat. $36^{\circ}52'30''N.$, long. $119^{\circ}30'W.$ ²; and because the quadrangle covers $7\frac{1}{2}$ minutes of latitude and longitude. Since the quadrangle is a $7\frac{1}{2}$ -minute sheet, the scale of 1:31,680 is implied, as shown in the above table.

Examples of unit-area index numbers: (These all refer to the accompanying index maps, which are lettered from west to east and numbered from north to south by 15-minute areas). (1) Anaheim, A' 33, a "standard" or 15-minute quadrangle, one "unit-area"; (2) Barstow, C'-D' 29-30, a 30-minute quadrangle, covering four unit-areas; (3) Alturas, O-R 1-4, a 60-minute quadrangle covering sixteen unit-areas; (4) Academy, T 21 NE, a $7\frac{1}{2}$ -minute quadrangle, covering the north-east quarter of the unit-area T 21; (5) in the case of 6-minute quadrangles, which do not fit into this unit-area index system because they are irregular fractions of the 15-minute unit-area, the position of the southeast corner of the quadrangle is given as the index number, as for example Action, Z 31.

COLUMN 4: *Contour interval* or intervals.

COLUMN 5: *Survey date*: the date when the area was surveyed; not date of publication of the map.

COLUMN 6: *Pub. agency*: the agency that published the map. Maps of some areas have been published by more than one agency; in such cases the oldest survey is listed first.

COLUMN 7: *Revision date—agency*: date of revision and agency making revision of the published map. Most of the revisions, however, are cultural only.

COLUMN 8: *Other quadrangles covering area*: In this column are names of published contour maps that fall within or cover the area named in column 1.

* *Ed. note:* The 6-minute sheets covering Los Angeles County have also been reproduced by the War Department, 30th Engineers, on the scale 1:20,000.

² On maps lying within the boundaries of California, the point nearest the equator and Greenwich meridian is the southeast corner, since the whole of the State lies within north latitudes and west longitudes.

Altadena.....	Los Angeles	N3406-W11806/6 (Z 32)	5, 25	1924	GS	----	Los Angeles (15')
Alturas.....	Lassen, Modoc (reconnaissance)	N4100-W12000/60 (O-R 1-4)	200	1890?	GS	----	Pasadena (15')
Alturas (unpub.).....	Modoc	N4115-W12030/15 (P 3)	--	----	----	----	Alturas (60')
Alvord Mountain.....	San Bernardino	N3500-W11630/15 (F' 28)	--	----	----	----	Avawatz Mountains (60')
Amboy (unpub.).....	Riverside	N3400-W11500/60 (I'-L' 29-32)	--	----	----	1942	Cadiz Lake (15')
Amboy (compilation).....	San Bernardino						Cadiz Valley (15')
Amedee (unpub.).....	Lassen, Plumas	N4000-W12000/30 (Q-R 7-8)	--	----	----	----	Danby (15')
Ames (unpub.).....	San Bernardino	N3500-W11530/30 (I'-J' 27-28)	--	----	----	----	Essex (15')
Anacapa Island.....	Ventura	N3400-W11915/15 (U 32)	--	----	----	----	Fenner (15')
Anaconda (unpub.).....	Trinity	N4015-W12315/15 (E 7)	--	----	----	----	Iron Mountains (15')
Anaheim.....	Los Angeles	N3345-W11745/15 (A' 33)	25	1915	WD	----	Milligan (15')
	Orange			1894	GS	----	Honey Lake (60')
	San Bernardino					1942	Ivanpah (60')
							Hoaglin (30')
							Corona (30')
							Coyote Hills (7½')
							Garden Grove (7½')
							Olinda (7½')
							Orange (7½')
							La Brea (6')
							La Habra (6')
Anges National Forest (compiled; scale 1" = 2 miles).....	Los Angeles	N3410-W11730/40x80	500	1926	FS	1937	Shadow Mountains (15')
Angle.....	Ventura	N3430-W11736/6 (B' 30)	5	1930	GS	----	Plantation (15')
Annapolis.....	Sonoma	N3837.5-W12315/7.5 (E' 14 NE)	25	1943	GS	----	Chollame (30')
Annette.....	San Luis Obispo	N3537.5-W12007.5/7.5 (R 26 NW)	25	1942	WD	----	Santa Cruz (30')
Año Nuevo.....	San Mateo	N3700-W12215/15 (I 20)	50	1939	WD	----	Santa Cruz (30')
Año Nuevo (unpub.).....	San Mateo	N3700-W12215/7.5 (I 20 SE)	--	----	----	----	Año Nuevo (15')
	Santa Cruz					----	Sacramento (30')
Antelope.....	Placer	N3837.5-W12115/7.5 (M 14 NE)	5	1909	GS	----	Faircreek (15')
Antelope Plain.....	Sacramento	N3537.5-W11945/7.5 (S 26 NE)	5	1932	GS	----	Lost Hills (30')
Antioch.....	Kern	N3800-W12145/15 (K 16)	10	1907	GS	----	Birds Landing (7½')
	Contra Costa					----	Collinsville (7½')
	Sacramento					----	Denverton (7½')
	Solano					----	Honker Bay (7½')
Anvil Spring Canyon.....	Inyo	N3545-W11645/15 (E' 25)	--	----	----	----	Avawatz Mountains (60')
Anvil Spring Canyon (unpub.).....	San Bernardino					----	Mount Pinos (30')
Apache Canyon.....	Kern, Ventura	N3445-W11915/7.5 (U 29 SE)	50	1942	WD	----	Colusa (15')
Arbuckle.....	Colusa	N3900-W12200/7.5 (J 12 SE)	5	1905	GS	----	Sacramento (30')
Arcade.....	Placer	N3837.5-W1222.5/7.5 (M 14 NW)	5	1909	GS	----	Fair Oaks (15')
	Sacramento					----	
	Sutter					----	

Bakersfield East. (unpub.)	Kern	N3515-W11845/15 (W 27)	--	----	----	----	Bakersfield, Sp. Caliente (30') Edison (7½') Fairfax School (7½') Oil Center (7½') North of Olddale (7½') Oil Center (7½') Olddale (7½') Buena Vista Lake (30') Gosford (7½') Olddale (7½') Rosedale (7½') Stevens (7½') Blue Lake (15') Owens Lake and Vicinity, Sp. Owens Valley Central, Sp. Mount Pinos (30')
Bakersfield Special	Kern	N3522.5-W11852.5/15 (V-W 26-28)	20	1904	GS	----	----
Bakersfield West. (compilation)	Kern	N3515-W11900/15 (V 27)	25	----	----	1942	WD
Bald Mountain (unpub.)	Humboldt	N4045-W12345/7.5 (C 5 SE)	100	1911	GS	----	----
Ballarat	Inyo	N3600-W11700/60 (A-D' 21-24)	50	1943	WD	----	----
Ballinger Canyon	Kern	N3452.5-W11922.5/7.5 (U 29 NW)	50	----	----	----	----
Bangor	Santa Barbara Ventura Butte, Yuba	N3915-W12115/15 (M 11)	50	1941	GS	----	----
Banner Hill (see Special Maps)	Nevada						
Banning	Riverside	N3345-W11645/15 (E' 33)	50	1942	WD	----	----
Bannock (provisional)	San Bernardino	N3445-W11445/15 (M' 29)	100	----	----	1942	WD
Barnwell (unpub.)	San Bernardino	N3500-W11500/30 (K'-L' 27-28)	100	1942	WD	----	----
Barrel Spring	Imperial	N3300-W11600/15 (H' 36)	100	----	----	----	----
Barstow	San Diego	N3430-W11700/30 (C'-D' 29-30)	100	1932	GS	----	----
Barstow (unpub.)	San Bernardino	N3445-W11700/15 (D' 29)	100	1932	GS	----	----
Barthe	Shasta	N4100-W12130/30 (K-L 3-4)	100	----	----	----	----
Barthe (unpub.)	Siskiyou	N4115-W12145/15 (K 3)	--	----	----	----	----
Bartlett Springs	Colusa	N3900-W12230/15 (H 12)	100	1916	WD	----	----
Bayles (unpub.)	Lake Shasta	N4045-W12215/15 (I 5)	50 --	1941	GS	----	----
Bear Mountain	Kern	N3507.5-W11837.5/7.5 (X 28 NW)	5	1930	GS	----	----
Bearcamp Mountain (unpub.)	Lassen	N4100-W12000/15 (R 4)	--	----	----	----	----
Beartrap Canyon	Modoc Los Angeles	N3436-W11842/6 (X 30)	25	1932	GS	----	----
Beegum Peak (unpub.)	Shasta	N4015-W12245/15 (G 7)	--	1923	GS	----	----
Bell	Los Angeles	N3354-W11806/6 (Z 33)	5	----	----	----	----
Bellota (compilation)	Sacramento San Joaquin	N3800-W12100/15 (N 16)	5	----	----	1941	WD
							Black Mountain (7½') Cobblestone Mountain (7½') Red Bluff (60') San Pedro (30') Downey (15') Lodi (30') Clements (7½') Linden (7½') Lockeford (7½') Waterloo (7½')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Belridge	Kern	N3522.5-W11937.5/7.5 (T 27 NW)	25	1943	WD	---	---	McKittrick (30')
Ben Lomond	San Mateo	N3657-W12200/18x15 (J 20)	100	1940	WD	---	---	Santa Cruz (30')
Bena	Kern	N3515-W11837.5/7.5 (X 27 SW)	5	1929	GS	---	---	Caliente (30')
Bennetts Well (unpub.)	Inyo	N3600-W11645/15 (E' 24)	--	---	---	---	---	Breckenridge Mountain (15')
Benton (unpub.)	Mono	N3745-W11830/15 (X 17)	--	---	---	---	---	Furnace Creek (60')
Berenda	Madera	N3700-W12007.5/7.5 (R 20 SW)	5	1916	GS	---	---	Mount Morrison (30')
Berry (unpub.)	San Bernardino	N3500-W11600/30 (G'-H' 27-28)	--	---	---	---	---	Awawatz Mountains (60')
Bethany	Alameda	N3745-W12130/7.5 (L 17 SE)	5	1911	GS	---	---	Byron (15')
Bidwell Bar	Contra Costa	N3930-W12100/30 (M-N 9-10)	100	1888	GS	---	---	Modoc Lava Bed (60')
Bieber (unpub.)	Yuba	N4100-W12100/30 (M-N 3-4)	--	---	---	---	---	Modoc Lava Bed (60')
Bieber (unpub.)	Lassen, Modoc	N4100-W12100/15 (N 4)	200	1911	GS	---	---	San Geronio (30')
Big Bar and Vicinity (Scale 1:250,000)	Humboldt	N4030-W12300/30 (E-F 5-6)	--	---	---	---	---	Modoc Lava Bed (60')
Big Bear Lake (unpub.)	Trinity	N3400-W11645/15 (E' 32)	--	---	---	---	---	Modoc Lava Bed (60')
Big Bend (unpub.)	San Bernardino	N4100-W12145/15 (K 4)	--	---	---	---	---	Bartle (30')
Big Bend Mountain (unpub.)	Shasta	N3930-W12115/15 (M 10)	--	---	---	---	---	Bidwell Bar (30')
Big Dune (unpub.)	Siskiyou	N3630-W11630/15 (F' 22)	--	---	---	---	---	Furnace Creek (60')
Big Lagoon (unpub.)	Yuba	N4107.5-W12400/7.5 (B 4 NE)	--	---	---	---	---	Bullfrog (30')
Big Meadows (unpub.)	Humboldt	N3815-W12000/15 (R 15)	--	---	---	---	---	Trinidad (15')
Big Maria Mountains	Calaveras	N3345-W11430/15 (N' 33)	50	1943	WD	---	---	Big Trees (30')
Big Pine (unpub.)	Tuolumne	N3700-W11815/15 (Y 20)	--	---	---	---	---	Blythe (60')
Big Pine Mountain (unpub.)	Riverside	N3430-W11930/15 (T 30)	--	---	---	---	---	Bishop (30')
	Fresno, Inyo							Santa Ynez (30')
	Santa Barbara							Big Pine Mountain (7½')
								Hildreth Peak (7½')
								Little Pine Mountain (7½')
								Strawberry Peak (7½')
Big Pine Mountain	Santa Barbara	N3437.5-W11937.5/7.5 (T 30 NW)	50	1943	WD	---	---	Santa Ynez (30')
Big Sage Reservoir (unpub.)	Modoc	N4130-W12030/15 (P 2)	--	---	---	---	---	Alturas (60')
Big Trees	Alpine, Anador, Calaveras, Tuolumne	N3800-W12000/30 (Q-R 15-16)	100	1891	GS	---	---	Mother Lode, Sp.
Biggs	Butte	N3922.5-W12137.5/7.5 (L 11 NW)	5	1910	GS	---	---	Marysville (30')
Biola	Fresno, Madera	N3645-W12000/7.5 (R 21 SE)	5	1920	GS	---	---	Gridley (15')

Birds Landing.....	Solano	N3807.5-W12145/7.5 (K 16 NE)	10, 15	1907	GS	Antioch (15')
Bishop.....	Fresno, Inyo	N3700-W11800/30 (Y-Z 19-20)	100	1911	GS	Owens Valley, Central, Sp.
Bishop (unpub.).....	Mono					
Black Butte.....	Inyo, Mono	N3715-W11815/15 (X 19)	5	1930	GS	Bishop (30')
Black Mountain.....	Los Angeles	N3430-W11742/6 (B' 30)	50	1942	WD	Alpine Butte (15')
	Ventura	N3437.5-W11845/7.5 (W 30 SE)				Shadow Mountain (15')
						Tejon (30')
						Beartrap Canyon (6')
						Black Mountain (6')
						Gorman (6')
						Quail (6')
						Tejon (30')
Black Mountain.....	Los Angeles	N3436-W11848/6 (W 30)	25	1932	GS	Black Mountain (7½')
Black Peak.....	San Bernardino	N3400-W11400/15 (P' 32)	50	---	WD	Needles (60')
(provisional)						Parker (30')
Blackcap Mountain.....	Fresno	N3700-W11845/15 (W20)	--	---	---	Mount Goddard (30')
Blackwell.....	Kern	N3530-W11945/7.5 (S 26 SE)	25	1942	WD	Lost Hills (30')
Blarsden.....	Plumas	N3945-W12030/15 (P 9)	50	1937	GS	Downville (30')
Blake (unpub.).....	San Bernardino	N3430-W11500/30 (K'-L' 29-30)	---	---	---	Amboy (60')
						Danby (15')
						Essex (15')
						Fenner (15')
						Bishop (30')
Blanco Mountain.....	Inyo	N3715-W11800/15 (Z 19)	--	---	---	
(unpub.)	Mono					
Bliss Ranch.....	Madera, Merced	N3700-W12022.5/7.5 (Q 20 SW)	5	1916	GS	Athlone (15')
Blossom (unpub.).....	Tehama	N4000-W12215/15 (I 8)	---	---	---	Red Bluff (60')
Blue Creek Mountain.....	Del Norte	N4122.5-W12345/7.5 (C 3 NE)	---	---	---	Hoopa (30')
(unpub.)	Humboldt	N4030-W12330/30 (C-D 5-6)	---	---	---	Techtah Creek (15')
Blue Lake (unpub.).....	Humboldt					Blue Lake (15')
	Trinity					China Flat (15')
						Kneeland (15')
						Pilot Creek (15')
						Korbel (15')
						Blue Lake (15')
						Big Trees (30')
Blue Lake.....	Humboldt	N4045-W12345/15 (C 5)	--	1922	WD	
Blue Lake (unpub.).....	Humboldt	N4052.5-W12352.5/7.5 (C 5 NW)	---	---	---	
Blue Mountain.....	Amador	N3815-W12015/15 (Q 15)	---	---	---	
(unpub.)	Calaveras					
	Tuolumne					
	Imperial					
Blythe.....	Riverside	N3300-W11400/60 (M'-P' 33-36)	500	1940	WD	Big Maria Mountains (15')
						Cibola (15')
						Dome Rock Mountains (15')
						Ehrenberg (15')
						Midland (15')
						Moon Mountain (15')
						Picacho (15')
						Duncans Mills (15')
Bodega Head.....	Marin	N3815-W12300/7.5 (F 15 SE)	25	1942	GS	
	Sonoma					
Bodie (unpub.).....	Mono	N3800-W11900/15 (V 16)	--	---	---	Bridgeport (30')
Bollinas (unpub.).....	Marin	N3752.5-W12237.5/7.5 (H 17 NW)	---	---	---	Tamalpais (15')
Bollipokka Mountain.....	Shasta	N4045-W12200/15 (J 5)	---	---	---	Red Bluff (60')
(unpub.)						Redding (30')

Calistoga-----	Lake, Napa, Sonoma	N3830-W12230/15 (H 14)	20	1915	WD	-----	-----	Sierraville (30')
Calpine (unpub.)-----	Plumas, Sierra	N3930-W12015/15 (Q 10)	50	1943	GS	-----	-----	Placerville (30')
Camino (unpub.)-----	El Dorado	N3830-W12030/15 (P 14)	--	-----	-----	-----	-----	Cucamonga (15')
Camp Baldy-----	Los Angeles	N3412-W11736/6 (B' 32)	25	1934	GS	-----	-----	San Antonio (15')
Camp Bonita-----	Los Angeles	N3412-W11742/6 (B' 32)	25	1934	GS	-----	-----	Cucamonga (15')
Camp Creek (unpub.)--	Del Norte	N4115-W12330/15 (D 3)	--	-----	-----	-----	-----	Pomona (15')
Camp Mohave-----	Humboldt	N3500-W11400/60 (M' P' 25-28)	250	1884	GS	1942	WD	Rock Creek (15')
Camp Nelson (unpub.)--	Siskiyou	N3600-W11830/15 (X 24)	25	1934	GS	-----	-----	Carrizo (30')
Camp Rincon-----	San Bernardino	N3412-W11748/6 (A' 32)	25	1934	GS	-----	-----	Calabasas (15')
Campo-----	Los Angeles	N3230-W11615/15 (G' 38)	100	1942	WD	-----	-----	Piru (15')
Camulos-----	San Diego	N3400-W11830/30 (W-X 31-32)	100	1901	GS	-----	-----	Santa Susana (15')
	Ventura							Triunfo Pass (15')
								Arroyo Sequit (6')
								Castaic (6')
								Chatsworth (6')
								Dry Canyon (6')
								Dume Point (6')
								Las Flores (6')
								Newhall (6')
								Pico (6')
								Reseda (6')
								Russell Valley (6')
								Santa Felicia Canyon (6')
								Saugus (6')
								Seminole (6')
								Solstice Canyon (6')
								Topanga Canyon (6')
								Zelzah (6')
								Corona (30')
								Santiago Peak (15')
								Alturas (60')
								Alturas (60')
								Coalinga (30')
								Polvadero Gap (15')
								Preston Peak (30')
								Ship Mountain (15')
								Salton Sink, Sp.
								Salton Sea (60')
								Cache Creek River Survey, Sp.
								Putah Creek River Survey, Sp.
								Esparto (7½)
Canada, Gobernadora---	Orange	N3330-W11730/7.5 (B' 34 SE)	--	-----	-----	-----	-----	
Canby (unpub.)-----	Riverside	N4100-W12030/30 (O-P 3-4)	--	-----	-----	-----	-----	
Canby (unpub.)-----	Lassen, Modoc	N4115-W12045/15 (O 3)	--	-----	-----	-----	-----	
Canby (unpub.)-----	Modoc	N3600-W12007.5/7.5 (R 24 SW)	5, 25	1930	GS	-----	-----	
Canoads Creek-----	Fresno, Kings	N4137.5-W12352.5/7.5 (C 2 NW)	--	-----	-----	-----	-----	
Canthook Mountain----	Del Norte	N3330-W11530/15 (J' 34)	50	1943	WD	-----	-----	
Canyon Spring-----	Riverside	N3830-W12200/15 (J 14)	20	1915	WD	-----	-----	
Capay-----	Napa		50	1943	GS	-----	-----	
	Yolo							

Clear Creek.....	Butte	N3937.5-W12137.5/7.5 (L 10 NW)	5	1910	GS	Chico (30')
Clear Lake Reservoir (unpub.)	Modoc	N4145-W12100/15 (N 1)	--	----	----	Oroville (15')
Clearwater.....	Los Angeles	N3348-W11806/6 (Z 33)	5	1923	GS	Modoc Lava Bed (60')
Clements.....	Anador	N3807.5-W12100/7.5 (N 16 NE)	10	1907	GS	San Pedro (30')
Clovis (unpub.).....	San Joaquin	N3645-W11930/15 (T 21)	--	----	----	Downey (15')
	Fresno					Lodi (30')
	Mariposa					Bellota (15')
						Academy (7½')
						Clovis (7½')
						Friant (7½')
						Round Mountain (7½')
Clovis.....	Fresno	N3645-W11937.5/7.5 (T 21 SW)	5	1921	GS	Indio, Sp.
Coachella.....	Riverside	N3330-W11600/15 (H' 34)	100	1942	WD	Salton Sea and Vicinity, Sp.
						Salton Sink, Sp.
Coal Mines (unpub.).....	Fresno	N3607.5-W12022.5/7.5 (Q 24 NW)	--	----	----	Coalinga (30')
Coal Oil Canyon.....	Kern	N3500-W11900/7.5 (V 28 SE)	5, 25	1931	GS	Coalinga (15')
Coalinga.....	Fresno, Kings, Monterey	N3600-W12000/30 (Q-R 23-24)	100	1910	GS	Buena Vista Lake (30')
						Coalinga (15')
						Joaquin Rocks (15')
						Polvadero Gap (15')
						Canoa Creek (7½')
						Delta Farms (7½')
						Guajarral Hills (7½')
						Huron (7½')
						Kreyenhagen Hills (7½')
						La Cima (7½')
						Mouth of Cantua Creek (7½')
						Towne Oil Station (7½')
						West of Lethent (7½')
						Wheatville (7½')
Coalinga.....	Fresno	N3600-W12015/15 (Q 24)	50	1941	GS	Coalinga (30')
Cobblestone Mountain	Monterey	N3430-W11845/7.5 (W 30 SE)	50	1942	WD	Kreyenhagen Hills (7½')
	Los Angeles					Tejon (30')
	Ventura					Beartap Canyon (6')
Coja Creek (unpub.).....	Santa Cruz	N3652.5-W12207.5/7.5 (J 21 NW)	100	1887	GS	Whitaker Peak (6')
Colfax.....	Nevada	N3900-W12030/30 (O-P 11-12)	100	1887	GS	Santa Cruz (30')
	Piacer					American River Survey, Sp.
Collegeville (unpub.).....	San Joaquin	N3745-W12100/15 (N 17)	--	----	----	Banner Hill, Sp.
						Avena (7½')
						Burnham (7½')
						Manteca (7½')
						Peters (7½')
						Antioch (15')
Collinsville.....	Contra Costa	N3800-W12145/7.5 (K 16 SE)	5, 10	1907	GS	San Bernardino (15')
	Sacramento					Big Trees (30')
	Solano					
Colton.....	Riverside	N3400-W11715/7.5 (C' 32 SE)	5, 25	1938	GS	
Columbia (unpub.).....	San Bernardino	N3800-W12015/15 (Q 16)	--	----	----	
	Calaveras					
	Tuolumne					

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Colusa	Colusa	N3900-W12200/15 (J 12)	10	1905	GS	1942	WD	Sacramento Valley, Sp. Arbuckle (7½') Powell Slough (7½') Spring Valley (7½') Williams (7½') Callente (30') Arvin (7½') Tejon Hills (7½') Weed Patch (7½') Cholame (30') San Pedro (30') Downey (15') Redondo (15') Maxwell (15')
Comanche Point (unpub.)	Kern	N3500-W11845/15 (W 28)	--	---	---	---	---	
Commatti Canyon	San Luis Obispo	N3530-W12015/7.5 (Q 26 SE)	25	1942	WD	---	---	
Compton	Los Angeles	N3348-W11812/6 (Z 33)	5	1923	GS	1928	GS	
Compton Landing	Colusa	N3915-W12200/7.5 (J 11 SE)	5	1904	GS	---	---	
Concord	Alameda	N3745-W12200/15 (J 17)	25	1894	GS	1914	WD	
Condrey Mountain	Contra Costa	N4145-W12245/15 (G 1)	--	---	---	---	---	
Conejo (unpub.)	Siskiyou		--	---	---	---	---	Shasta (60') Yreka (30')
Conejo	Fresno	N3630-W11937.5/7.5 (T 22 SW)	5	1922	GS	---	---	
Conner	Kern	N3507.5-W11900/7.5 (V 28 NE)	5	1930	GS	---	---	Buena Vista Lake (30')
Cooperstown	Stanislaus	N3737.5-W12030/7.5 (P 18 NE)	5	1913	GS	---	---	
Copco (unpub.)	Tuolumne		--	---	---	---	---	
Copperopolis	Siskiyou	N4145-W12215/15 (I 1)	--	---	---	---	---	Shasta (60') MacDoel (30') Mother Lode, Sp.
Corcoran	Stanislaus	N3745-W12030/15 (P 17)	25	1914	GS	1939	WD	
Corcoran (compilation)	Tuolumne	N3600-W11930/15 (T 24)	25	---	---	1942	WD	Corcoran (7½') El Rico Ranch (7½') Guernsey (7½') Waukena (7½') Corcoran (15') Anaheim (15') Corona (15')
Corcoran	Kings		--	---	---	---	---	Santa Ana (15')
Corona	Tulare	N3600-W11930/7.5 (T 24 SE)	5	1926	GS	---	---	Santiago Peak (15')
	Los Angeles	N3330-W11730/30 (A'-B' 33-34)	100	1899	GS	---	---	Corona and Vicinity (7½')
	Orange		--	---	---	---	---	Coyote Hills (7½')
	Riverside		--	---	---	---	---	El Toro (7½')
	San Bernardino		--	---	---	---	---	Garden Grove (7½')
			--	---	---	---	---	Newport Beach (7½')
			--	---	---	---	---	Olinda (7½')
			--	---	---	---	---	Orange (7½')
			--	---	---	---	---	Prado (7½')
			--	---	---	---	---	Tustin (7½')
			--	---	---	---	---	La Brea (6')
			--	---	---	---	---	La Habra (6')

Corona	Orange Riverside	N3345-W11730/15 (B' 33)	50	1942	WD	Corona (30')
Corona (unpub.)	San Bernardino	N3345-W11737.5/7.5 (B' 33 SW)	--	----	----	Corona and Vicinity (7½')
Corona	Orange	N3350-W11730/10x7.5 (B' 33 NE)	5	1933	GS	Prado (7½')
Corona and Vicinity	Riverside	N3600-W11730/15 (B' 24)	--	----	----	Corona (30')
Coso Peak (unpub.)	San Bernardino	N3822.5-W12107.5/7.5 (N 15 NW)	5	1907	GS	Corona (15')
Cosumnes	Inyo	N3330-W11545/15 (I' 34)	50	1942	WD	Corona (30')
Cottonwood Spring	Riverside					Ballarat (60')
Coulterville (unpub.)	Mariposa	N3730-W12000/15 (R 18)	--	----	----	Lodi (30')
Courtland	Sacramento	N3815-W12130/15 (L 15)	10	1906	GS	Salton Sea and Vicinity, Sp.
	Solano					Salton Sink, Sp.
	Yolo					Salton Sea (60')
Covelo (unpub.)	Mendocino	N3930-W12300/30 (E-F 9-10)	--	----	----	Mother Lode District, Sp.
	Trinity					Sonoma (30')
Covelo	Mendocino	N3945-W12300/15 (F 9)	50	1924	GS	Babel Slough (7½')
Covelo (Spy Rock)	Trinity	N3945-W12315/15 (E 9)	100	1916	WD	Cache Slough (7½')
Covina	Los Angeles	N3400-W11748/6 (A' 32)	5, 25	1925	GS	Saxon (7½')
Cow Track Mountain	Mono	N3745-W11845/15 (W 17)	--	----	----	Varden (7½')
Coxcomb Mountains	Riverside	N3345-W11515/15 (K' 33)	50	1943	WD	Del River Survey, Sp.
Coyote Hills	Orange	N3352.5-W11752.5/7.5 (A' 33 NW)	5, 25	1932	GS	Covelo (15')
Coyote Peak	Humboldt	N4100-W12345/15 (C 4)	50	1942	WD	Eden Valley (15')
Coyote Peak (unpub.)	Humboldt	N4107.5-W12345/7.5 (C 4 NE)	--	----	----	Laytonville (15')
Coyote Wells	Imperial	N3230-W11545/15 (I' 38)	25, 50	1943	WD	Spy Rock (15')
						Eel River Survey, Sp.
Crafton Hills	San Bernardino	N3400-W11700/7.5 (D' 32)	--	----	----	Pomona (15')
Crank Mountain	Modoc	N4115-W12100/15 (N 3)	--	----	----	Mount Morrison (30')
Cranell (unpub.)	Humboldt	N4100-W12400/7.5 (B 4 SE)	--	----	----	Salton Sea (60')
Crescent City (tactical)	Del Norte	N4130-W12400/30 (A-B 1-2)	100	1921	WD	Corona (30')
Crescent City (unpub.)	Del Norte	N4145-W12407.5/7.5 (B 1 SW)	--	----	----	Anaheim (15')
Crescent Peak (unpub.)	San Bernardino	N3515-W11500/15 (L' 27)	--	----	----	Hoopa (30')
						Hoopa (30')
						Coyote Peak (15')
						Salton Sink, Sp.
						El Centro (60')
						El Centro (30')
						Redlands (15')
						Modoc Lava Bed (60')
						Trinidad (30')
						Trinidad (15')
						Point St. George (15')
						Requa (15')
						Crescent City (30')
						Point St. George (15')
						Ivanpah (60')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Cressy	Merced	N3722.5-W12037.5/7.5 (P 19 NW)	5	1914	GS	---	---	
Cross Mountain	Stanislaus	N3515-W11800/15 (Z 27)	100	1943	WD	---	---	Mojave (30')
Crows Landing	Kern	N3722.5-W12100/7.5 (N 19 NE)	5	1914	GS	---	---	Orestimba (15')
Crucero (unpub.)	Stanislaus	N3500-W11600/15 (H' 28)	25	1936	GS	---	---	Avawatz Mountains (60')
Crystal Lake	Los Angeles	N3418-W11748/6 (A' 31)	25	1936	GS	---	---	Rock Creek (15')
Cucamonga	Riverside	N3400-W11730/15 (B' 32)	50	1894	GS	1941	WD	Guasti and Vicinity (7½')
	San Bernardino							Ontario and Vicinity (7½')
								Camp Baldy (6')
								Camp Bonita (6')
								Claremont (6')
								Evey Canyon (6')
								La Verne (6')
								Searles Lake (60')
Cuddeback Lake (unpub.)	San Bernardino	N3515-W11715/15 (C' 27)	--	---	---	---	---	Mount Pinos (30')
Cuddy Valley	Kern	N3445-W11900/7.5 (V 29 SE)	50	1943	WD	---	---	
Cummings	Ventura	N3945-W12330/15 (D 9)	100	1916	WD	---	---	Caliente (30')
Cummings Mountain	Mendocino	N3500-W11830/15 (X 28)	100	1943	WD	---	---	Bear Mountain
Cupertino (unpub.)	Kern	N3715-W12200/7.5 (J 19 SE)	--	---	---	---	---	Santa Cruz (30')
Cuyama Peak (unpub.)	Santa Cruz	N3445-W11915/15 (U 29)	--	---	---	---	---	Palo Alto (15')
	Kern							Mount Pinos (30')
	San Luis Obispo							Apache Canyon (7½')
	Santa Barbara							Ballinger Canyon (7½')
	Ventura							Cuyama Peak (7½')
Cuyama Peak	Santa Barbara	N3445-W11922.5/7.5 (U 29 SW)	50	1942	WD	---	---	Santiago Creek (7½')
Cuyama Ranch	Ventura	N3452.5-W11937.5/7.5 (T 29 NW)	50	1943	WD	---	---	Mount Pinos (30')
Cuyama	San Luis Obispo	N3230-W11630/30 (E'-F' 37-38)	100	1902	GS	---	---	Santa Ynez (30')
Cuyamaca	Santa Barbara							Cuyamaca Peak (15')
	San Diego							El Cajon (15')
								Jamul (15')
								Potrero (15')
Cuyamaca Peak	San Diego	N3245-W11630/15 (F' 37)	50	1942	GS	---	---	Cuyamaca (30')
Cuyapaipe	San Diego	N3245-W11615/15 (G' 37)	100	1942	WD	---	---	Carrizo (30')
Daggett (unpub.)	San Bernardino	N3430-W11630/30 (E'-F' 29-30)	--	---	---	---	---	
Daggett (unpub.)	San Bernardino	N3445-W11645/15 (E' 29)	--	---	---	---	---	
Dale (unpub.)	Riverside	N3400-W11530/30 (I'-J' 31-32)	--	---	---	---	---	
Dale Lake (unpub.)	San Bernardino	N3400-W11530/15 (J' 32)	--	---	---	---	---	Amboy (60')
	Riverside							Amboy (60')
Danby (provisional)	San Bernardino	N3430-W11515/15 (K' 30)	100	---	---	1943	WD	Amboy (60')
Dardanelles	Alpine, Mono, Tuolumne	N3800-W11930/30 (S-T 15-16)	100	1896	GS	---	---	Yosemite National Park, Sp.

Dardanelles Cone. (unpub.)	Alpine	N3815-W11945/15 (S 15)	--	---	Dardanelles (30')
Dardanelles (unpub.)	Tuolumne	N3615-W11730/15 (B' 23)	---	---	Ballarat (60')
Darwin (unpub.)	Inyo	N3700-W11952.5/7.5 (S 20 SW)	5	1916	Mariposa (30')
Daulton	Madera	N3700-W12207.5/7.5 (J 20 SW)	---	---	Raymond (15')
Davenport (unpub.)	Santa Cruz	N4130-W12015/15 (Q 2)	---	---	Santa Cruz (30')
Davis Creek (unpub.)	Modoc	N3745-W11806/13 (Z 17)	---	---	Ben Lomond (15')
Davis Mountain. (unpub.)	Mono	N3830-W12130/15 (L 14)	10	1905	Alturas (60')
Davisville	Sacramento		---	---	White Mountain (60')
Deep Creek	Sutter		---	---	Sacramento Valley, Sp.
Deepwell Ranch	Yolo		---	---	Elkhorn Weir (7½')
Del Mar	San Bernardino	N3415-W11700/15 (D' 31)	50	1899	Grays Bend (7½')
Del Norte	Kern	N3537.5-W11900/7.5 (V 26 NE)	5, 25	1928	Lovdal (7½')
Delano	San Diego	N3252.5-W11707.5/7.5 (D' 37 NW)	5, 25	1939	Swingle (7½')
Delevan	Los Angeles	N3436-W11812/6 (Z 30)	5	1931	Slater (15')
Delta Farms (unpub.)	Kern	N3545-W11907.5/7.5 (V 25 SW)	5	1926	La Jolla (15')
	Tulare	N3915-W12207.5/7.5 (J 11 SW)	5	1904	Elizabeth Lake (30')
	Colusa	N3615-W12000/15 (R 23)	---	---	Terra Bella (15')
	Fresno		---	---	Maxwell (15')
Delta Farms	Fresno	N3615-W12007.5/7.5 (R 23 SW)	5	1928	Coalinga (30')
Delta Ranch	Merced	N3700-W12037.5/7.5 (P 20 SW)	5	1916	Delta Farms (7½')
Denair	Stanislaus	N3730-W12045/7.5 (O 18 SE)	5	1914	Towne Oil Station (7½')
Denver	Salano	N3807.5-W12152.5/7.5 (K 16 NW)	5, 10	1907	West of Lethent (7½')
Desert Creek Peak. (unpub.)	Mono	N3830-W11915/15 (U 14)	---	---	Wheatville (7½')
Devilwater Creek. (unpub.)	Kern	N3522.5-W11952.5/7.5 (S 27 NW)	---	---	Coalinga (30')
Devils Heart Peak.	San Luis Obispo	N3430-W11852.5/7.5 (W 30 SW)	50	1942	Modesto East (15')
Devils Postpile.	Ventura	N3730-W11900/15 (V 18)	---	---	Antioch (15')
Devore. (unpub.)	Fresno	N3407.5-W11722.5/7.5 (C' 32 NW)	5	1936	Wellington (30')
Dillon Mountain. (unpub.)	San Bernardino	N4130-W12330/15 (D 2)	---	---	McKittrick (30')
Dinuba	Siskiyou	N3630-W11900/30 (U-V 21-22)	100	1921	Simmler (15')
	Fresno, Tulare		---	---	Tejon (30')
			---	---	Mount Lyell (30')
			---	---	San Bernardino (15')
			---	---	Preston Peak (30')
			---	---	Dunlap (15')
			---	---	Watts Valley (15')
			---	---	Citrus Cove (7½')
			---	---	Orangedale School (7½')
			---	---	Reedley (7½')
			---	---	Stokes Mountain (7½')
			---	---	Sultana (7½')
			---	---	Wahoke (7½')

Duncan Peak (unpub.)	Placer	N3900-W12030/15 (P 12)	200	1915	WD	Colfax (30')
Duncans Mills	Sonoma	N3815-W12300/15 (F 15)				Arched Rock (7½')
Duncans Mills	Sonoma	N3822.5-W12300/7.5 (F 15 NE)	25	1943	GS	Bodega Head (7½')
Dunlap	Fresno, Tulare	N3630-W11900/15 (V 22)	50	1942	GS	Duncans Mills (15')
Dunnigan	Colusa	N3845-W12145/15 (K 13)	10	1905	GS	Dinuba (30')
	Sutter					Stokes Mountain (7½')
	Yolo					Sacramento Valley, Sp.
Dunsmuir	Shasta	N4100-W12200/30 (I-J 3-4)	100	1931	GS	Hershey (7½')
	Siskiyou					Kirkville (7½')
	Trinity					Ronda (7½')
Dunsmuir (unpub.)	Shasta	N4100-W12215/15 (I 4)	--			Zamorra (7½')
	Siskiyou					Mount Shasta, Sp.
	Trinity					Shasta (60')
Durham	Butte	N3937.5-W12145/7.5 (K 10 NE)	5	1910	GS	Dunsmuir (30')
Durmid	Imperial	N3815-W11545/15 (I' 35)	25	1942	WD	Chico (30')
	Riverside					Salton Sea and Vicinity, Sp.
Dwinnell Reservoir	Siskiyou	N4130-W12215/15 (I 2)	--			Salton Sea (60')
(unpub.)						MacDoel (30')
Dyerville	Humboldt	N4015-W12345/15 (C 7)	100	1916	WD	Honey Lake (60')
Eagle Lake (unpub.)	Lassen	N4030-W12030/30 (O-P 5-6)	--			Honey Lake (60')
Eagle Lake East	Lassen	N4030-W12030/15 (P 6)	--			Honey Lake (60')
(unpub.)						Furnace Creek (60')
Eagle Lake West	Lassen	M 4030-W12045/15 (O 6)	--			Salton Sea (60')
(unpub.)						Canyon Spring (15')
Eagle Mountain	Inyo	N3600-W11615/15 (G' 24)	--			Cottonwood Spring (15')
(unpub.)						Eagle Tank (15')
Eagle Mountains	Riverside	N3330-W11530/30 (I'-J' 33-34)	--			Linkham Well (15')
(unpub.)						Alturas (60')
						Mount Pinos (30')
Eagle Peak (unpub.)	Lassen, Modoc	N4100-W12000/30 (Q-R 3-4)	50	1943	WD	Santa Cruz (30')
Eagle Rest Peak	Kern	N3452.5-W11900/5/7.5 (V 29 NW)	--			Ben Lomond (15')
Eagle Rock (unpub.)	San Mateo	N3707.5-W12207.5/7.5 (J 20 NW)	--			Alturas (60')
	Sanja Cruz					Allensworth (7½')
Eagle Tank	Riverside	N3345-W11530/15 (I' 33)	50	1942	WD	Alpaugh (7½')
Eagleville (unpub.)	Modoc	N4115-W12000/15 (R 3)	25			Pixley (7½')
Earlmar	Kern	N3545-W11915/15 (U 25)	--			Stone (7½')
(compilation)	Tulare					Elk Hills Oil Field, Sp.
East Elk Hills	Kern	N3515-W11922.5/7.5 (U 27 SW)	15, 20	1927	GS	Buena Vista Lake (30')
						Buttonwillow (15')

[illegible]

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Etna	Shasta	N4100-W12230/30 (G-H 3-4)	100	1931	GS	---	---	Trinity River Survey, Sp. Shasta (60')
Etna (unpub.)	Siskiyou	N4115-W12245/15 (G 3)	--	---	---	---	---	Shasta (60')
Eureka	Trinity	N4045-W12400/15 (B 5)	20, 100	1916	WD	---	---	Etna 30'
Evev Canyon	Siskiyou	N3406-W11736/6 (B' 32)	50	1933	GS	---	---	
La Verne Sheet	Humboldt	N3615-W11900/15 (V 23)	--	---	---	---	---	Cucamonga (15')
Exeter (unpub.)	Los Angeles	N3615-W11900/15 (V 23)	--	---	---	---	---	Guasti and Vicinity (7½')
Exeter	Tulare	N3615-W11907.5/7.5 (V 23 SW)	5, 25	1925	GS	---	---	Ontario and Vicinity (7½')
Eylar Mountain	Alameda	N3722.5-W12130/7.5 (L 19)	--	---	---	---	---	Exeter (7½')
Fairfax School	Kern	N3515-W11852.5/7.5 (W 27 SW)	5	1929	GS	---	---	Ivanhoe (7½')
Fairmead (unpub.)	Madura	N3700-W12000/15 (R 20)	--	---	---	---	---	Lenon Cove (7½')
Fairmont	Merced	N3442-W11824/6 (Y 30)	5, 25	1932	GS	---	---	Rocky Hill (7½')
Fairoaks	Los Angeles	N3830-W12115/15 (M 14)	10	1901	GS	1942	WD	Mount Hamilton (15')
Fairview	Placer	N3907.5-W12215/7.5 (I 12 NE)	5	1905	GS	---	---	Caliente (30')
Fairview	Sutter	N3830-W11907.5/7.5 (V 26 SW)	5	1920	GS	1939	GS	Berenda (7½')
Fallen Leaf Lake	Colusa	N3745-W12045/15 (O 17)	25	---	---	---	---	Kismet (7½')
Farming (unpub.)	Kern	N3507.5-W11930/7.5 (T 28 NE)	50	1943	WD	---	---	Le Grand (7½')
Farmington (completion)	Santa Cruz	N3700-W12200/7.5 (J 20 SE)	--	---	---	---	---	Raynor Creek (7½')
Fellows	San Luis Obispo	N3445-W11500/15 (L' 29)	100	---	---	---	---	Elizabeth Lake (30')
Felton (unpub.)	Santa Cruz	N4030-W12415/15 (A 6)	50	1940	GS	---	---	Willow Springs (15')
Fenner (provisional)	San Bernardino	N3645-W11945/15 (S 21)	--	---	---	---	---	Sacramento (30')
Ferrdale	Humboldt		--	---	---	---	---	Antelope (7½')
Figarden (unpub.)	Fresno		--	---	---	---	---	Arcade (7½')
	Madera		--	---	---	---	---	Brighton (7½')
			--	---	---	---	---	Mills (7½')
			--	---	---	---	---	Wilbur Springs (15')
			--	---	---	---	---	Slater (15')
			--	---	---	---	---	Pyramid Peak (30')
			--	---	---	---	---	Bachelor Valley (7½')
			--	---	---	---	---	Oakdale (7½')
			--	---	---	---	---	Thalheim (7½')
			--	---	---	---	---	Trigo (7½')
			--	---	---	---	---	McKittrick (30')
			--	---	---	---	---	Santa Cruz (30')
			--	---	---	---	---	Ben Lomond (15')
			--	---	---	---	---	Amboy (60')
			--	---	---	---	---	Bullard (7½')
			--	---	---	---	---	Gregg (7½')
			--	---	---	---	---	Herndon (7½')
			--	---	---	---	---	Lanes Bridge (7½')

Firebaugh (unpub.)-----	Fresno Madera	N3645-W12015/15 (Q 21)	--	---	---	---	---	Firebaugh (7½') Kentucky Well (7½') Mendota (7½') Pozo Farm (7½')
Firebaugh-----	Fresno Madera	N3645-W12022.5/7.5 (Q 21 SW)	5	1920	GS	1939	GS	Alturas (60')
Fitzhugh Springs (unpub.)-----	Modoc	N4115-W12015/15 (Q 3)	--	---	---	---	---	Hawthorne (60')
Fletcher (unpub.)-----	Mono	N3800-W11830/30 (W-X 15-16)	--	1907	GS	---	---	Lodi (30')
Florin-----	Sacramento	N3822.5-W12122.5/7.5 (M 15 NW)	5	1942	GS	---	---	Franklin (15')
Flournoy-----	Glenn	N3945-W12215/15 (I 9)	50	---	---	---	---	Amboy (60')
Flynn (unpub.)-----	Tehama	N3445-W11530/15 (J' 29)	--	1941	GS	---	---	Sacramento (30')
Folsom-----	San Bernardino Anador El Dorado Placer	N3830-W12100/15 (N 14)	25	---	---	---	---	Buffalo Creek (7½')
Folsom-----	Sacramento	N3837.5-W12107.5/7.5 (N 14 NW)	5	1908	GS	---	---	Folsom (15')
Fontana-----	Sacramento Riverside	N3400-W11722.5/7.5 (C' 32 SW)	5, 25	1938	GS	---	---	San Bernardino (15')
Fort Bidwell (unpub.)-----	San Bernardino	N4130-W12000/30 (Q-R 1-2)	--	---	---	---	---	Alturas (60')
Fort Bidwell (unpub.)-----	Modoc	N4145-W12000/15 (R 1)	--	---	---	---	---	Alturas (60')
Fort Bragg (unpub.)-----	Modoc	N3900-W12330/30 (C-D 11-12)	--	---	---	---	---	Albion (15')
Fort Bragg (unpub.)-----	Mendocino	N3915-W12345/15 (C 11)	100	1916	WD	---	---	Fort Bragg (15')
Fort Bragg-----	Mendocino	N4130-W12245/15 (G 2)	50	1943	WD	---	---	Glenblair (15')
Fort Jones (unpub.)-----	Siskiyou	N3830-W12307.5/7.5 (F 14 SW)	25	1943	GS	---	---	Saddle Point (15')
Fort Ross-----	Sonoma	N4030-W12400/15 (B 6)	50	1942	GS	---	---	Shasta (60')
Fortuna-----	Humboldt	N3445-W11930/15 (T 29)	--	---	---	---	---	Yreka (30')
Fox Mountain (unpub.)-----	San Luis Obispo Santa Barbara	N3445-W11930/7.5 (T 29 SE)	50	1943	WD	---	---	Skaggs (15')
Fox Mountain Franklin (compilation) -	Santa Barbara Sacramento San Joaquin	N3815-W12115/15 (M 15)	5	---	---	1941	WD	Rohnerville (15')
Franklin Point-----	San Mateo (unpub.)-----	N3707.5-W12215/7.5 (I 20 NE)	--	---	---	---	---	Santa Ynez (30')
Frazier Mountain-----	Santa Cruz	N3445-W11852.5/7.5 (W 29 SW)	50	1943	WD	---	---	Bruceville (7½')
Frazier Mountain-----	Kern	N3607.5-W11852.5/7.5 (W 24 NW)	--	---	---	---	---	Elk Grove (7½')
Frazier Valley (unpub.)-----	Ventura Tulare		--	---	---	---	---	Florin (7½')
			--	---	---	---	---	Galt (7½')
			--	---	---	---	---	Santa Cruz (30')
			--	---	---	---	---	Año Nuevo (15')
			--	---	---	---	---	Tejon (30')
			--	---	---	---	---	Kaweah (30')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Fredonyer Peak (unpub.)	Lassen	N4045-W12030/15 (P 5)	--	----	----	----	----	Honey Lake (60')
Freel Peak (unpub.)	Alpine, Mono	N3845-W11945/15 (S 13)	--	----	----	----	----	Markleeville (30')
Freeman (unpub.)	Inyo, Kern, San Bernardino	N3530-W11730/30 (A'-B' 25-26)	--	----	----	----	----	Searles Lake (60')
	Tulare		--	----	----	----	----	Inyokern (15')
Fremont Peak (unpub.)	San Bernardino	N3500-W11715/15 (C' 28)	--	----	----	----	----	Searles Lake (60')
French Gulch (unpub.)	Shasta	N4030-W12230/15 (H 6)	--	----	----	----	----	Red Bluff (60')
Fresno (unpub.)	Trinity	N3630-W11945/15 (S 22)	--	----	----	----	----	Weaverville (30')
	Fresno		--	----	----	----	----	Caruthers (7½')
			--	----	----	----	----	Fresno (7½')
			--	----	----	----	----	Kearney Park (7½')
			--	----	----	----	----	Raisin (7½')
Fresno	Fresno	N3637.5-W11945/7.5 (S 22 NE)	5	1921	GS	----	----	
Friant	Fresno	N3652.5-W11937.5/7.5 (T 21 NW)	5, 25	1919	GS	----	----	
Frink	Madera		50	1942	WD	----	----	
	Imperial							
	Riverside							
Fruto	Glenn	N3930-W12215/15 (I 10)	50	1942	GS	----	----	Salton Sea and Vicinity, Sp.
								Salton Sink, Sp.
Funeral Mountains (unpub.)	Inyo	N3630-W11645/15 (E' 22)	--	----	----	----	----	Salton Sea (60')
Funeral Peak (unpub.)	Inyo	N3600-W11630/15 (F' 24)	--	----	----	----	----	Kurand (7½')
Furnace Creek	Inyo	N3600-W11600/60 (E'-H' 21-24)	100	1906	GS	----	----	Walker Creek (7½')
Furnace Creek (unpub.)	Inyo	N3600-W11630/30 (E'-F' 23-24)	--	----	----	----	----	Furnace Creek (60')
Furnace Creek (unpub.)	Inyo		--	----	----	----	----	Bullfrog (30')
			--	----	----	----	----	Furnace Creek (60')
			--	----	----	----	----	Furnace Creek (60')
Galt (unpub.)	Sacramento	N3615-W11645/15 (E' 23)	--	----	----	----	----	
Garberville (unpub.)	San Joaquin	N3815-W12115/7.5 (M 15 SE)	5	1908	GS	----	----	Furnace Creek (60')
	Humboldt							
	Trinity	N4000-W12330/30 (C-D 7-8)	--	----	----	----	----	Lodi (30')
Garden Grove	Orange	N3345-W11752.5/7.5 (A' 33 SW)	5	1932	GS	----	----	Franklin (15')
Garzas Creek (unpub.)	Merced	N3700-W12045/15 (O 20)	--	----	----	----	----	Briceland (15')
								Dyerville (15')
								Harris (15')
								South Fork Peak (15')
								Corona (30')
								Anaheim (15')
								Ingomar (7½')
								Los Banos (7½')
								San Luis Ranch (7½')
								Volta (7½')
Gas Point (unpub.)	Shasta	N4015-W12230/15 (H 7)	--	----	----	----	----	Red Bluff (60')
	Tehama							
Gasquet	Del Norte	N4145-W12345/15 (C 1)	50	1942	WD	----	----	Preston Peak (30')
Gasquet (unpub.)	Del Norte	N4145-W12352.5/7.5 (C 1 SW)	--	----	----	----	----	Preston Peak (30')
			--	----	----	----	----	Gasquet (15')
Gaviota	Santa Barbara	N3415-W12000/15 (R 31)	50	1942	WD	----	----	Lompoc (30')

Genesee.....	Plumas	N4005-W12045 (O-P 8)	50	1891	GS	---	Honey Lake (60')
(not standard quad range; scale 1:31,680) Georgetown (unpub.)----							
Giant Gap (unpub.)-----	Calaveras	N3845-W12045/15 (O 13)	--	---	---	---	Placerville (30')
Giers Basin.....	El Dorado	N3000-W12045/15 (O 12)		---	---	---	Cofax (30')
(provisional)	Nevada, Placer	N3415-W11400/15 (P' 31)	50	---	WD	1943	Needles (60')
Gilroy Hot Springs-----	San Bernardino	N3700-W12115/15 (M 20)	50	1918	GS	WD	Parker (30')
Gilziser Slough-----	Santa Clara	N3900-W12137.5/7.5 (L 12 SW)	5	1909	GS *	---	Marysville Buttes and Vicinity, Sp.
	Stanislaus						Marysville (30')
	Imperial	N3245-W11500/15 L' 37)	50	---	---	---	Marysville (15')
	Mendocino	N3915-W12330/15 (D 11)	100	1916	WD	WD	El Centro (60')
	Los Angeles	N3406-W11812/6 (Z 32)	5, 25	1925	GS	---	Holtville (30')
	Los Angeles	N3406-W11748/6 (A' 32)	5, 25	1925	GS	---	Los Angeles (15')
	Kern	N3330-W11830/15 (X 26)	500	1919	WD	---	Pasadena (15')
	Tulare	N3600-W11845/7.5 (W 24 SE)		---	---	---	Santa Monica (15')
	Humboldt	N4015-W12400/15 (B 7)	100	1916	WD	---	Pomona (15')
	Placer	N3852.5-W12107.5/7.5 (N 13 NW)	--	---	---	---	Tobias Peak (30')
	San Bernardino	N3515-W11645/15 (E' 27)	--	---	---	---	Rabweah (30')
	Santa Barbara	N3415-W11945/15 (S 31)	50	1902	GS	---	Sacramento (30')
	Monterey	N3630-W12115/15 (M 22)	50	1942	WD	---	Auburn (15')
	San Benito	N3542.5-W11525/20x10 (J'-K' 24-26)	50	1917	GS	WD	Avawatz Mountains (60')
	San Bernardino			1916	GS	---	
	Amador	N3815-W12100/7.5 (N 15 SE)	10	1907	GS	---	Ivanpah (60')
	Sacramento						Lodi (30')
	San Joaquin	N3530-W11930/7.5 (T 26 SE)	5	1927	GS	---	Lost Hills (30')
	Kern	N4000-W12415/15 (A 8)	100	1926?	WD	---	Hart Station (15')
	Humboldt	N3442-W11848/6 (W 30)	25	1938	GS	---	Tejon (30')
	Los Angeles						Black Mountain (7½')
	Kern	N3515-W11900/7.5 (V 27 SE)	5	1929	GS	---	Lebec (7½')
	Kings, Tulare	N3615-W11922.5/7.5 (U 23 SW)	5	1924	GS	---	Buena Vista Lake (30')
	Kern	N3522.5-W11945/7.5 (S 27 NE)	--	---	---	---	Bakersfield West (15')
	El Dorado	N3900-W12015/15 (Q 12)	--	---	---	---	McKittrick (30')
	Granite Chief (unpub.)-						Simmler (15')
	Placer						Truckee (30')

Hopkins Well	Riverside	N3330-W11500/15 (L' 34)	50	1943	WD	Salton Sea (60')
Hopland	Mendocino	N3845-W12300/15 (F 13)	100	1942	WD	
Hornbrook (unpub.)	Sonoma	N4145-W12230/15 (H 1)	--	---	---	Shasta (60')
Howard Ranch	Siskiyou	N3707.5-W12100/7.5 (N 20 NE)	5, 25	1916	GS	Yreka (30')
Huasna (unpub.)	Merced	N3500-W12000/30 (Q-R 27-28)	--	---	---	Pacheco Pass (15')
	Stanislaus					Branch Mountain (15')
	San Luis Obispo					La Panza (15')
	Santa Barbara					Nipomo (15')
Hueneme	Ventura	N3400-W11900/15 (V 32)	50	1901	GS	Pozo (15')
Hughes Lake	Los Angeles	N3436-W11824/6 (Y 30)	25	1932	GS	Elizabeth Lake (30')
Hillville	Lake	N3915-W12245/15 (G 11)	100	1916	WD	Lake Pillsbury (15')
Humphreys	Los Angeles	N3424-W11824/6 (Y 31)	5, 25	1929	GS	San Fernando (15')
Huntington Lake	Fresno	N3700-W11900/15 (V 20)	--	---	---	Kaiser (30')
(unpub.)						
Huntoon Valley	Mono	N3800-W11830/15 (X 16)	--	---	---	Hawthorne (60')
(unpub.)						
Hupa Mountain	Humboldt	N4100-W12345/7.5 (C 4 SE)	--	---	---	Hoopa (30')
(unpub.)						Coyote Peak (15')
Hurdygurdy Butte	Del Norte	N4145-W12345/7.5 (C 1 SE)	--	---	---	Preston Peak (30')
(unpub.)						Gasquet (15')
Huron	Fresno	N3607.5-W12000/7.5 (R 24 NE)	5	1933	GS	Coalinga (30')
	Kings					Polvadero Gap (15')
Hyampom (unpub.)	Trinity	N4030-W12315/15 (E 6)	--	---	---	Big Bar and Vicinity (30')
Hyattens Spring (unpub.)	San Bernardino	N3445-W11600/15 (H' 29)	--	---	---	Needles (60')
Ibis (unpub.)	San Bernardino	N3430-W11430/30 (M'-N' 29-30)	--	---	---	Needles (30')
						Bannock (15')
						Center Hills (15')
						Needles (15')
						Sawtooth Range (15')
						San Diego (15')
Imperial Beach	San Diego	N3230-W11707.5/7.5 (D' 38 SW)	--	---	---	Mount Whitney (30')
(unpub.)						Owens Creek (7½')
Independence (unpub.)	Inyo	N3645-W11800/15 (Z 21)	25	1916	GS	Panoche (30')
Indian Gulch	Mariposa	N3715-W12000/15 (R 19)	--	---	---	Chaney Ranch (7½')
(unpub.)	Merced					Monocline Ridge (7½')
Indian Peak (unpub.)	Fresno	N3630-W12030/15 (P 22)	--	---	---	Tierra Loma School (7½')
	San Benito					Tukey Hills (7½')
						Honey Lake (60')
Indian Valley	Plumas	N4000-W12039/11x21 (O 8)	100	1891	GS	
(not standard quad- range; scale 1:63,500)						

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Indio..... (not standard quad- rangle; scale 1:125,000)	Imperial Riverside San Diego	N3315-W11600/35x30 (G'H' 33-35)	100	1901	GS	----	----	Salton Sea and Vicinity, Sp. Salton Sink, Sp. Agua Dulce (15') Clark Lake (15') Coachella (15') Edom (15') Toro Peak (15') Englebrecht Ranch (7½') Levis (7½')
Ingle (unpub.).....	Fresno	N3630-W12015/15 (Q 22)	--	----	----	----	----	Tranquility (7½') Tufts Ranch (7½') San Pedro (30') Redondo (15')
Inglewood.....	Los Angeles	N3354-W11818/6 (Y 33)	5	1923	GS	1929	GS	Searles Lake (60') Salton Sink, Sp. Salton Sea (60') Salton Sink, Sp. Salton Sea (60') Amboy (60')
Ingomar.....	Merced	N3707.5-W12052.5/7.5 (O 20 NW)	5	1916	GS	----	----	Big Bar and Vicinity (30')
Inyokern.....	Kern	N3530-W11745/15 (A' 26)	50	1943	WD	----	----	Gustine (7½')
Iris.....	Imperial	N3300-W11515/15 (K' 36)	25, 50	1943	WD	----	----	Mitchell School Stevenson (7½')
Iris Pass.....	Imperial	N3315-W11515/15 (K' 35)	25	1943	WD	----	----	Turlock (7½')
Iron Mountains..... (provisional)	Riverside	N3400-W11500/15 (L' 32)	100	----	----	1943	WD	Kernville (30')
Ironsides Mountain..... (unpub.)	San Bernardino	N4045-W12315/15 (E 5)	--	----	----	----	----	Hoaglin (30')
Irwin (unpub.).....	Trinity Merced Stanislaus	N3715-W12045/15 (O 19)	--	----	----	----	----	Goodsprings, Sp. Ivanpah (60')
Isabella.....	Kern	N3530-W11815/15 (Y 26)	100	1943	WD	----	----	Willows (15')
Island Mountain.....	Trinity	N4000-W12315/15 (E 8)	100	1916	WD	----	----	Alturas (60')
Isleton.....	Sacramento San Joaquin	N3807.5-W12130/7.5 (L 16 NE)	5	1908	GS	----	----	Mother Creek (15')
Ivanhoe.....	Solano	N3622.5-W11907.5/7.5 (V 23 NW)	5, 25	1924	GS	----	----	Sutter Creek (15')
Ivanpah.....	San Bernardino	N3500-W11500/60 (I'-L' 25-28)	100	1910	GS	----	----	Valley Springs (15')
Jacinto.....	San Bernardino	N3515-W11515/15 (K' 27)	--	----	----	----	----	Woodland (15')
Jacks Butte (unpub.).....	Butte, Glenn	N3930-W12200/7.5 (J 10 SE)	--	1904	GS	----	----	Salton Sink, Sp.
Jackson.....	Modoc	N4130-W12045/15 (O 2)	100	1888	GS	----	----	Carrizo (30')
Jacobs Corner.....	Anador	N3800-W12030/30 (O-P 15-16)	5, 10	1905	GS	----	----	Kernan (15')
Jacumba.....	Calaveras	N3837.5-W12152.5/7.5 (K 14 NW)	100	1942	WD	----	----	Cuyamaca (30')
Jamesburg.....	Yolo	N3230-W11600/15 (H' 38)	5	1922	GS	----	----	
Jameson.....	San Diego	N3637.5-W12007.5/7.5 (R 22 NW)	50	1917	GS	1940	WD	
Jamul.....	Fresno	N3230-W11645/15 (E' 38)	50	1939	GS	----	----	

San Bernardino	San Diego	N2327.5-W11652.5/7.5 (E' 38 NW)	--	---	---	---	Cuyamaca (30')
Jamul (unpub.)	San Bernardino	N3530-W11500/30 (K' L' 25-26)	--	---	---	---	Jamul (15')
Jean (unpub.)	Lassen, Shasta	N4045-W12115/15 (M 5)	--	---	---	---	Ivanpah (60')
Jellotte (unpub.)	Contra Costa	N3800-W12137.5/7.5 (L 16 SW)	5, 10	1908	GS	---	Lassen Peak (60')
Jersey	Sacramento						Halls Flat (30')
	Solano						
Joaquin Rocks	Fresno	N3615-W12015/15 (Q 23)	50	1941	GS	---	Coalinga (30')
Johannesburg (unpub.)	Kern	N3500-W11730/15 (B' 28)	--	---	---	---	Mouth of Cantua Creek (7½')
Joshua	San Bernardino	N3442-W11748/6 (A' 30)	5	1930	GS	---	Kramer Borate District, Sp.
	Los Angeles						Searles Lake (60')
Jubilee Pass (unpub.)	Inyo	N3545-W11630/15 (F' 25)	--	---	---	---	Alpine Butte (15')
	San Bernardino						Rogers Lake (15')
Junipero Serra	Monterey	N3600-W12115/15 (M 24)	50	1917	GS	---	Avawatz Mountains (60')
Kaiser	Fresno, Madera	N3700-W11900/30 (U-V 19-20)	100	1902	GS	1940	
Kane Spring (unpub.)	San Bernardino	N3430-W11630/15 (F' 30)	--	---	---	---	
	Imperial	N3300-W11545/15 (I' 36)	25	1942	WD	---	
Karlo (unpub.)	Lassen	N4030-W12000/30 (Q-R 5-6)	--	---	---	---	
Karlo (unpub.)	Lassen	N4030-W12015/15 (Q-6)	--	---	---	---	Salton Sea and Vicinity, Sp.
Kaweah	Tulare	N3600-W11830/30 (W-X 23-24)	100	1902	GS	---	Salton Sea (60')
Kaweah (unpub.)	Tulare	N3615-W11845/15 (W 23)	--	---	---	---	Honey Lake (60')
Kearney Park	Fresno	N3637.5-W11952.5/7.5 (S 22 NW)	5	1920	GS	---	Honey Lake (60')
Keders	Butte	N3945-W12145/7.5 (K 9 SE)	5	1910	GS	---	Sequoia and General Grant
							National Park, Sp.
Kedler (unpub.)	Inyo	N3615-W11745/15 (A' 23)	--	---	---	---	Kaweah (30')
Keller Peak (unpub.)	San Bernardino	N3407.5-W11700/7.5 (D' 32 NE)	--	---	---	---	Chico (30')
Kelseyville	Lake	N3845-W12245/15 (G 13)	100	1916	WD	---	Richardson Springs (15')
	Mendocino						Ballarat (60')
	Sonoma						Redlands (15')
Kelso (unpub.)	San Bernardino	N3500-W11530/15 (J' 28)	100	1916	WD	---	
Kenny	Mendocino	N3945-W12345/15 (C 9)	5	1919	GS	---	Ivanpah (60')
Kentucky Well	Madera	N3652.5-W12015/7.5 (Q 21 NE)	--	---	---	---	Amboy (60')
Kerens (unpub.)	San Bernardino	N3445-W11545/15 (I' 29)	--	---	---	---	Helm (7½')
Kerman (compilation)	Fresno	N3630-W12000/15 (R 22)	--	---	---	1941	Jarvis (7½')
							Kerman (7½')
							San Joaquin (7½')
Kerman	Fresno	N3637.5-W12000/7.5 (R 22 NE)	5	1920	GS	---	Kerman (15')
Kern Island (unpub.)	Kern	N3500-W11900/15 (V 28)	--	---	---	---	Buenos Vista Lake (30')
							Coal Oil Canyon (7½')
							Comer (7½')
							Hayes Ranch
							Millux (7½')
Kern Peak (unpub.)	Tulare	N3615-W11815/15 (Y 23)	--	---	---	---	Olancha (30')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Kern River Oil Field. (2 sheets, North and South; not standard quadrangle; scale 1:12,000)	Kern	N3525-W11856/5x6 (V-W 27)	20	1904	GS	---	---	Kern River Survey, Sp. Buena Vista Lake (30') Caliente (30') Oil Center (7½') Oildale (7½') Kern River Survey, Sp. Isabella (15') Onyx (15') Stratford (15') Cholame (30') Dardanelles (30') Amboy (60') Cadiz Lake (15') Cadiz Valley (15') Iron Mountains (15') Milligan (15') Junipero Serra (15') King City (15') Mesa (15') Soledad (15')
Kernville.	Kern Tulare	N3530-W11800/30 (Y-Z 25-26)	100	1906	GS	---	---	
Kettleman City.	Kings	N3600-W11952.5/7.5 (S 24 SW)	5, 25	1933	GS	---	---	
Kettleman Plain.	Kings	N3552.5-W12000/7.5 (R 25 NE)	5, 25	1930	GS	---	---	
Kibbie Ridge (unpub.).	Tuolumne	N3800-W11945/15 (S 16)	---	---	---	---	---	
Kilbeck (unpub.).	Riverside San Bernardino	N3400-W11500/30 (K'-L' 31-32)	---	---	---	---	---	
King City (unpub.).	Monterey San Benito	N3600-W12100/30 (M-N 23-24)	---	---	---	---	---	
King City.	Monterey	N3600-W12100/15 (N 24)	50	1918	GS	1940	WD	
Kingston Peak. (unpub.)	San Bernardino	N3530-W11545/15 (I' 26)	--	---	---	---	---	Ivanpah (60')
Kirkville.	Colusa, Sutter	N3852.5-W12145/7.5 (K 13 NE)	5	1905	GS	---	---	Dunnigan (15')
Kirkwood.	Glenn, Tehama	N3945-W12207.5/7.5 (J 9 SW)	5	1904	GS	---	---	Vina (15')
Kismet.	Madera	N3700-W12000/7.5 (R 20 SE)	5	1916	GS	---	---	
Klamath National Forest								
East half (compiled; scale 1"=2 miles)	Siskiyou	N4100-W12230/65x50	200	1933	FS	---	---	
West half (compiled; scale 1"=2 miles)	Trinity							
Del Norte	Humboldt							
Trinity	Siskiyou, Trinity							
Kneeland.	Humboldt	N4030-W12345/15 (C 6)	100	1916	WD	---	---	Copperopolis (15')
Knights Ferry (unpub.)	Calaveras	N3745-W12037.5/7.5 (P 17 SW)	--	---	---	---	---	
Knights Landing.	Tuolumne	N3845-W12187.5/7.5 (L 13 SW)	5	1908	GS	---	---	
Korbel.	Humboldt	N4045-W12345/15 (C 5)	100	1916	WD	---	---	Blue Lake (15')
Korbel (unpub.).	Humboldt	N4045-W12332.5/7.5 (C 5 SW)	---	---	---	---	---	Blue Lake (15')
Kramer.	Kern	N3445-W11736/15 (B' 29)	25	1937	GS	---	---	Adobe (6') Hi Vista (6')
	Los Angeles							
Kramer Borate District (not standard quadrangle; scale 1:24,000)	San Bernardino Kern	N3500-W11737/5x9 (B' 28)	5	1932	GS	---	---	Searles Lake (60') Castle Butte (15')
Kreyenhagen Hills.	San Bernardino	N3600-W12015/7.5 (Q 24 SE)	5, 25	1936	GS	---	---	Coalinga (30')
Kurand.	Fresno	N3930-W12215/7.5 (I 10 SE)	5	1904	GS	---	---	Coalinga (15') Fruto (15')
	Glenn							

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Lancaster (unpub.)	Los Angeles	N3430-W11800/15 (Z 30)	--	---	---	---	---	Elizabeth Lake (30') Del Sur (6') Esperanza School (6') Lancaster (6') Oban (6') Palmdale (6') Pearland (6') Red Rover (6') Roosevelt School (6') Tierra Bonita (6') Elizabeth Lake (30') Marysville (30') Butte Sink (15') Avawatz Mountains (60')
Lancaster Landow	Los Angeles	N3436-W11806/6 (Z 30) N3922.5-W12145/7.5 (K 11 NE)	5, 25 5	1930 1910	GS GS	---	---	Ivanpah (60')
Lane Mountain (unpub.)	San Bernardino	N3500-W11645/15 (E' 28)	--	---	---	---	---	San Fernando (15') San Pedro (30') Seal Beach (7½') Long Beach (6') Wilmington (6') Cannulos (30') Catabasas (15') Concord (15')
Lanes Bridge	Fresno, Madera	N3652.5-W11945/7.5 (S 21 NE)	5, 25	1919	GS	---	---	Deer Creek River Survey, Sp. Lassen Volcanic National Park, Sp.
Laifair Valley	San Bernardino	N3500-W11500/15 (L' 28)	--	---	---	---	---	Burney (30') Halls Flat (30') Mineral (30') Lassen Peak (60') Mineral (30')
Lang (unpub.)	Los Angeles	N3424-W11818/6 (Y 31)	25	1929	GS	---	---	Lassen Peak (60') Burney (30') Halls Flat (30') Mineral (30')
Las Bolsas	Los Angeles	N3330-W11800/15 (Z 34)	25	pre-1900 1941	GS WD	---	---	Lida (60')
Las Flores	Los Angeles	N3400-W11836/6 (X 32)	25	1929	GS	---	---	
Las Trampas Ridge (unpub.)	Alameda	N3745-W12200/7.5 (J 17 SE)	--	---	---	---	---	
Las Vegas (unpub.)	Contra Costa	N3600-W11500/60 (I'-L' 21-24)	100	1907	GS	---	---	
Lassen National Forest (not standard quadrangle; scale 1:48,000)	Butte, Lassen, Plumas, Shasta, Tehama	N3940-W12040/20x80	200	1936	FS	---	---	
Lassen Peak (reconnaissance)	Butte, Lassen, Plumas, Shasta, Tehama	N4000-W12100/60 (K-N 5-8)	200	1884	GS	---	---	
Lassen Peak (unpub.)	Shasta, Tehama	N4015-W12130/15 (L 7)	--	---	---	---	---	
Lassen Volcanic National Park (not standard quadrangle; scale 1:48,000)	Lassen, Plumas, Shasta, Tehama	N4025-W12115/10x20	50	1926	GS	---	---	
Last Chance Range (unpub.)	Inyo	N3700-W11730/15 (B' 20)	--	---	---	---	---	
Lathrop	San Joaquin	N3745-W12115/7.5 (M 17 SE)	5	1912	GS	---	---	
Laton	Fresno, Kings	N3622.5-W11937.5/7.5 (T 23 NW)	5	1924	GS	---	---	

Lava Peak (unpub.)	Lasen	N4045-W12045/15 (O 5)	--	---	---	Honey Lake (60')
Lavie (unpub.)	San Bernardino	N3430-W11615/15 (G' 30)	100	1916	WD	Searles Lake (60')
Laytonville	Mendocino	N3930-W12315/15 (E 10)	---	---	---	
Layton Canyon (unpub.)	San Bernardino	N3530-W11700/15 (D' 26)	5	1915	GS	
Le Grand	Madera	N3707.5-W12007.5/7.5 (R 20 NW)	---	---	---	
	Merced					
Leach Lake (unpub.)	San Bernardino	N3530-W11630/15 (F' 26)	50	1943	WD	Avawatz Mountains (60')
Lebec	Kern	N3445-W11845/7.5 (W 29 SE)	---	---	---	Tejon (30')
	Los Angeles					Gorman (6')
	Ventura					Quail (6')
Leeks Spring Hill (unpub.)	Amador	N3830-W12015/15 (Q 14)	--	---	---	Pyramid Peak (30')
Leeland (unpub.)	El Dorado	N3630-W11630/30 (E'-F' 21-22)	--	---	---	Furnace Creek (60')
	Inyo					Furnace Creek (60')
Lees Well (unpub.)	Inyo	N3615-W11630/15 (F' 23)	5, 25	1925	GS	Burrell (7½')
Lemon Cove	Tulare	N3622.5-W11900/7.5 (V 23 NE)	---	---	---	Lemoore (7½')
Lemoore (unpub.)	Fresno	N3615-W11945/15 (S 23)	---	---	---	Lethent (7½')
	Kings					Riverdale (7½')
Lemoore	Kings	N3615-W11945/7.5 (S 23 SE)	5	1924	GS	Wasco (15')
Leonards	Kern	N3530-W11922.5/7.5 (U 26 SW)	5	1927	GS	Elizabeth Lake (30')
Leonis Valley (unpub.)	Los Angeles	N3430-W11815/15 (Y 30)	--	---	---	Bouquet Reservoir (6')
						Del Sur (6')
						Esperanza School (6')
						Fairmont (6')
						Hughes Lake (6')
						Lake (6')
						Little Buttes (6')
						Red Rover (6')
						San Francisco (6')
Lethent	Fresno, Kings	N3615-W11952.5/7.5 (S 23 SW)	5	1924	GS	Hacienda Ranch (7½')
Levis	Fresno	N3630-W12022.5/7.5 (Q 22 SW)	5, 25	1921	GS	Harvester (7½')
Liberty Farms	Kern	N3545-W11930/15 (T 25)	25	---	---	Lost Tree Well (7½')
(compilation)	Kings					West Albion (7½')
	Tulare					Silver Peak (30')
						Tejon (30')
						Nearbach (15')
Lida	Inyo, Mono	N3700-W11700/60 (A'-D' 17-20)	100	1911	GS	Tejon (30')
Liebre	Los Angeles	N3442-W11836/6 (X 30)	5, 25	1932	GS	Beartrap Canyon (6')
						Liebre (6')
Liebre Mountain (unpub.)	Los Angeles	N3430-W11830/15 (X 30)	--	---	---	Manzana (6')
						Quail (6')
						Red Mountain (6')
						Redrock Mountain (6')
						Violin Canyon (6')
						Warm Spring (6')
						Whitaker Peak (6')

Lodi (compilation)	Sacramento San Joaquin	N3800-W12115/15 (M 16)	5	---	1941	WD	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lodi	Sacramento San Joaquin	N3800-W12115/15 (M 16)	5	---	1941	WD	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lodoga	Colusa	N3915-W12215/15 (I 11)	50	1942	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Logan Creek	Glenn	N3922.5-W12215/7.5 (I 11 NE)	5	1904	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Logandale	Colusa, Glenn	N3922.5-W12207.5/7.5 (J 11 NW)	5	1904	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lokern	Kern	N3522.5-W11930/7.5 (T 27 NE)	5	1931	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lompoc	San Luis Obispo	N3427.5-W12000/32.5x30(Q-R 29-31)	100	1903	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lompoc	Santa Barbara	N3427.5-W12000/32.5x30(Q-R 29-31)	100	1903	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lompoc	Santa Barbara	N3430-W12015/15 (Q 30)	50	1942	WD	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lone Pine (unpub.)	Inyo	N3630-W11800/15 (Z 22)	--	---	---	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lone Tree Creek (unpub.)	Alameda	N3730-W12122.5/7.5 (M 18 SW)	--	---	---	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lone Tree Valley	Stanislaus	N3752.5-W12145/7.5 (K 17 NE)	5	1913	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Lone Tree Well	Contra Costa	N3545-W11937.5/7.5 (T 25 SW)	5	1932	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Long Barn (unpub.)	Kern, Kings	N3800-W12000/15 (R 16)	--	---	---	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope (71½') Woodbridge (71½') Logan Creek (71½') Sites (71½') Lodoga (15') Maxwell (15') McKittrick (30') Gaviota (15') Lompoc (15') Los Olivos (15') Point Conception (15') Santa Maria (15') Tepusquet Peak (15') Lompoc (30') Mount Whitney (30') Carbona (15')
Long Beach	Tuolumne	N3344-W11805/4x7 (Z 34)	--	1923	GS	---	Waterloo (71½') Woodbridge (71½') Lodi (30') Castle (71½') Headreach (71½') New Hope

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Los Olivos.....	Santa Barbara	N3430-W12000/15 (R 30)	50	1942	WD	---	---	Lompoc (30')
Los Viejos Hills.....	Kings	N3552.5-W11952.5/7.5 (S 25 NW)	5, 25	1930	GS	---	---	Lost Hills (30') La Rambla (15') Hart Station (15') La Rambla (15')
Lost Hills..... (topography not completed)	Kern	N3530-W11930/30 (S-T 25-26)	100	1908	GS	---	---	Liberty Farms (15') Antelope Plain (7½') Avenal Gap (7½') Blackwell (7½') Dudley Ridge (7½') Emigrant Hill (7½') Goose Lake (7½') Hacienda Ranch (7½') Harvester (7½') Lone Tree Well (7½') Los Viejos Hills (7½') Miramonte Ranch (7½') Reynolds Ranch (7½') Shale Point (7½') West Albaugh (7½') West Camp (7½') West of Goose Lake (7½') Davisville (15')
Lovdal.....	Sacramento	N3830-W12130/7.5 (L 14 SE)	5	1905	GS	---	---	Alpine Butte (15') Putah Creek River Survey, Sp.
Lovejoy Springs.....	Yolo	N3436-W11748/6 (A' 30)	5	1930	GS	---	---	Sierraville (30')
Lower Lake.....	Los Angeles	N3845-W12230/15 (H 13)	100	1916	WD	---	---	San Geronio (30')
Loyalton (unpub.).....	Sonoma	N3930-W12000/15 (R 10)	50	1943	GS	---	---	Willows (15') White Mountain (30') Blythe (60')
Lucerne Valley..... (unpub.)	Lassen, Plumas, Sierra	N3415-W11645/15 (E' 31)	--	---	---	---	---	Tejon (30')
Lucia..... (unpub.)	San Bernardino	N3600-W12130/15 (L 24)	--	---	---	---	---	Slater (15') Vina (15')
Ludlow (unpub.).....	Monterey	N3430-W11600/15 (H' 30)	50	1917	GS	1939	WD	Elk Hills Oil Field, Sp. Caliente Mountain (15') Simmler (15') Belridge (7½') Elkhorn Hills (7½')
Lyman.....	San Bernardino	N3930-W12207.5/7.5 (J 10 SW)	5	1904	GS	---	---	
McAfee Ranch (unpub.).....	Glenn	N3730-W11800/15 (Z 18)	--	---	---	---	---	
McCoy Spring..... (unpub.)	Riverside	N3330-W11445/15 (M' 34)	--	---	---	---	---	
McDonald Peak.....	unpub.	N3437.5-W11852.5/7.5 (W 30 NW)	50	1943	WD	---	---	
McFarland.....	Ventura	N3537.5-W11907.5/7.5 (V 26 NW)	5	1927	GS	---	---	
McIntosh Landing.....	Kern	N3945-W12200/7.5 (J 9 SE)	5	1904	GS	---	---	
McKittrick.....	Butte, Glenn, Tehama	N3500-W11930/30 (S-T 27-28)	5	1910	GS	---	---	
	Kern		100		GS	---	---	
	San Luis Obispo							
	Santa Barbara							

McPherson Peak.....	San Luis Obispo	N3445-W11945/15 (S 29)	100	1942	WD	Fellows (7½')
MacDoel.....	Santa Barbara	N4130-W12200/30 (L-J 1-2)	100	1933	GS	Loken (7½')
MacDoel (unpub.).....	Siskiyou	N4145-W12200/15 (J 1)	--	---	---	Midway Peak (7½')
Madeline (unpub.).....	Lassen, Modoc	N4100-W12015/15 (Q 4)	--	---	---	Olig (7½')
Madera (unpub.).....	Fresno	N3045-W12000/15 (R 21)	--	---	---	Panorama
	Madera		--	---	---	West Elk Hills (7½')
			--	---	---	Santa Ynez (30')
Madera.....	Madera	N3652.5-W12000/7.5 (R 21 NE)	5	1919	GS	Klamath River Survey, Sp.
Magruder Mountain.....	Inyo	N3715-W11730/15 (B' 19)	--	---	---	Shasta (60')
Maine Prairie.....	Solano	N3815-W12145/7.5 (K 15 SE)	5	1906	GS	Shasta (60')
Malaga.....	Fresno	N3637.5-W11937.5/7.5 (T 22 NW)	5	1921	GS	MacDoel (30')
Manly Peak (unpub.).....	Inyo	N3546-W11700/15 (D' 25)	--	---	---	Mturus (60')
Manter.....	San Bernardino	N3745-W12107.5/7.5 (N 17 SW)	5	1912	GS	Biola (7½')
Manton (unpub.).....	San Joaquin	N4015-W12145/15 (K 7)	--	---	---	Bonita Ranch (7½')
Manzana.....	Shasta	N3442-W11830/6 (X 30)	5, 25	1933	GS	Gravelly Ford (7½')
Manzanita Lake.....	Shasta	N4030-W12130/15 (L 6)	--	---	---	Madera (7½')
Marble Canyon.....	Inyo	N3630-W11715/15 (C' 22)	--	---	---	Lida (60')
Marble Mountains.....	Siskiyou	N4130-W12300/15 (F 2)	--	---	---	Vacaville (15')
Marcuse.....	Sutter	N3852.5-W12137.5/7.5 (L 13 NW)	5	1908	GS	Searles Lake (60')
Mare Island.....	Contra Costa	N3800-W12215/15 (I 16)	25	1914 1937	GS WD	Lassen Peak (60')
	Marin		--	---	---	Mineral (30')
Margarita Peak.....	Solano, Sonoma	N3315-W11715/15 (C' 35)	50	1941	WD	Tejon (30')
Maricopa.....	Riverside	N3500-W11922.5/7.5 (U 28 SW)	50	1943	WD	Neenach (15')
Marion Peak (unpub.).....	San Luis Obispo	N3645-W11830/15 (X 21)	--	---	---	Lassen Peak (60')
Mariposa.....	Fresno	N3700-W11930/30 (S-T 19-20)	100	1910	GS	Burney (30')
	Madera		--	---	---	Ballarat (60')
	Mariposa		--	---	---	Siad (30')
Mariposa (unpub.).....	Madera	N3715-W11945/15 (S 19)	--	---	---	Napa (30')
	Mariposa		--	---	---	San Luis Rey (30')
			--	---	---	Buena Vista Lake (30')
			--	---	---	Tehipite (30')
			--	---	---	Raymond (15')
			--	---	---	Daulton (7½')
			--	---	---	Little Table Mountain (7½')
			--	---	---	Sulphur Springs (7½')
			--	---	---	Mariposa (30')

Masonic Mountain (unpub.)	Mono	N3815-W11900/15 (V 15)	---	---	---	Pennington (7½')
Matterhorn Peak (unpub.)	Mono	N3800-W11915/15 (U 16)	---	---	---	Sanborn Slough (7½')
Maxwell	Tuolumne	N3915-W12200/15 (J 11)	10	1904	GS	Sutter (7½')
	Colusa					Tisdale Wier (7½')
	Glenn					Bridgeport (30')
						Bridgeport (30')
Mendocino National Forest.	Colusa	N3900-W12230/70x45	200	---	---	Sacramento Valley, Sp.
(scale 1" = 2 miles, compilation; originally published as California National Forest)	Glenn					Compton Landing (7½')
Mendocino National Forest	Mendocino					Delevan (7½')
Merced	Tehama, Trinity	N3645-W12015/7.5 (Q 21 SE)	5	1921	GS	Logandale (7½')
Merced Falls	Fresno, Madera	N3715-W12022.5/7.5 (Q 19 SW)	5	1914	GS	Princeton (7½')
	Merced	N3730-W12015/15 (Q 18)	50	1942	GS	
	Merced					Sonora (30')
	Stutskaus					La Grange (7½')
Merced Falls	Tuolumne	N3730-W12015/7.5 (Q 18 SE)	5	1916	GS	Merced Falls (7½')
	Mariposa					Sonora (30')
Merced Peak	Merced	N3730-W11915/15 (U 18)	---	---	---	Merced Falls (15')
(unpub.)	Madera					Mount Lyell (30')
Meridian	Mariposa					
	Colusa					Marysville Buttes and Vicinity, Sp.
Merritt	Sutter	N3907.5-W12152.5/7.5 (K 12 NW)	5	1910	GS	Marysville (30')
Mescal Creek	Solano, Yolo	N3830-W12145/7.5 (K 14 SE)	5	1905	GS	Woodland (15')
	Los Angeles	N3424-W11742/6 (B' 31)	5, 25	1934	GS	Rock Creek (15')
Mescal Range (unpub.)	San Bernardino	N3515-W11530/15 (J' 27)	---	---	---	San Antonio (15')
Metz	Monterey	N3615-W12100/15 (N 23)	50	1917	GS	Ivanpah (60')
	San Benito					
Michigan Bar	Amador	N3815-W12100/15 (N 15)	---	---	---	Lodi (30')
(unpub.)	Sacramento					Carbondale
						Clay (7½')
						Cosumnes (7½')
						Goose Creek (7½')
						Ivanpah (60')
						Blythe (60')
						Tesla (15')
						McKittrick (30')
Mid Hills (unpub.)	San Bernardino	N3500-W11515/15 (K' 28)	---	---	---	Elkhorn Hills (7½')
Midland	Riverside	N3345-W11445/15 (M' 33)	50	1943	WD	Fellows (7½')
Midway	Alameda	N3737.5-W12130/7.5 (L 18 NE)	5	1912	GS	Midway Peak, SW (7½')
	San Joaquin					Panorama Hills (7½')
Midway Peak (unpub.)	Kern	N3500-W11930/15 (T 28)	---	---	---	
	San Luis Obispo					

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Midway Peak	San Luis Obispo.	N3500-W11937.5/7.5 (T 28 SW)	50	1942	WD	---	---	McKittrick (30')
Southwest.	Imperial	N3290-W11500/15 (L' 38)	25	1943	WD	---	---	Salton Sink, Sp.
Midway Well								El Centro (60')
Milford (unpub.)	Lassen, Plumas	N4000-W12015/15 (Q 8)	50	1942	GS	---	---	Honey Lake (60')
Milerton Lake	Fresno	N3700-W11930/15 (T 20)				---	---	Volville (30')
Madera	Madera	N3415-W11500/15 (L' 31)				---	---	Mariposa (30')
Milligan (provisional)	San Bernardino	N3830-W12115/7.5 (M 14 SE)	100	1909	GS	1943	WD	Sulphur Springs (7½')
Mills	Sacramento		5			---	---	Amboy (60')
Millux	Kern	N3507.5-W11907.5/7.5 (V 28 NW)	5	1930	GS	---	---	Sacramento (30')
Milpitas (unpub.)	Alameda	N3722.5-W12152.5/7.5 (K 19 NW)				---	---	Faroaks (15')
Mindogo Hill	San Mateo					---	---	Buena Vista Lake (30')
(unpub.)	Santa Clara					---	---	San Jose (15')
Mineral	Santa Cruz	N3715-W12207.5/7.5 (J 19 SW)	--			---	---	Santa Cruz (30')
	Butte					---	---	Palo Alto (15')
	Shasta	N4000-W12130/30 (K-L 7-8)	100	1935	GS	---	---	Deer Creek Survey, Sp.
Minersville (unpub.)	Tehama					---	---	Lassen Volcanic National Park, Sp.
Minor Creek (unpub.)	Trinity	N4045-W12245/15 (G 5)	--			---	---	Lassen Peak (60')
Miramonite Ranch	Humboldt	N4052.5-W12345/7.5 (C 5 NE)				---	---	Red Bluff (60')
	Kern	N3537.5-W11930/7.5 (T 26 NE)	5	1927	GS	---	---	Weaverville (30')
Mitchell School	Merced	N3722.5-W12052.5/7.5 (O 19 NW)	5	1914	GS	---	---	Blue Lake (15')
Modesto East.	Stanislaus					---	---	Lost Hills (30')
(compilation)	San Joaquin	N3730-W12045/15 (O 18)	5			---	---	Hart Station (15')
	Stanislaus					---	---	Ceres (7½')
Modesto Reservoir.	Merced	N3730-W12030/15 (P 18)				---	---	Denair (7½')
(unpub.)	Stanislaus					---	---	Riverbank (7½')
	Tuolumne					---	---	Waterford (7½')
Modesto West.	San Joaquin	N3730-W12100/15 (N 18)	5, 25			---	---	Cooperstown (7½')
(compilation)	Stanislaus					---	---	Montpellier (7½')
						---	---	Paulsell (7½')
						---	---	Three Tree Flat (7½')
						---	---	Ripon (7½')
						---	---	Salida (7½')
						---	---	Westley (7½')
						---	---	Westport (7½')
						---	---	Bartle (30')
Modoc Lava Bed	Lassen, Modoc.	N4100-W12100/60 (K-N 1-4)	200	1885	GS	---	---	Camp Mohave (60')
(reconnaissance)	Shasta, Siskiyou					---	---	Camp Mohave (60')
Mohave City	San Bernardino	N3500-W11430/30 (M'-N' 27-28)	100	1926	GS	---	---	Mohave City (30')
	San Bernardino	N3500-W11430/15 (N' 28)	--			---	---	Cross Mountain (15')
Mojave	Kern	N3500-W11800/30 (Y-Z 27-28)	100	1913	GS	---	---	Emerald Mountain (15')
						---	---	Mojave (15')
						---	---	Tehachapi (15')

Mojave.....	Kern.....	N3500-W11800/15 (Z 28)	100	1943	WD	---	Mojave (30')
Mokelumne Hill.....	Calaveras.....	N3815-W12030/15 (P 15)	--	---	---	---	Jackson (30')
Monache Mountain.....	Inyo.....	N3600-W11800/15 (Z 24)	--	---	---	---	Olancho (30')
Mono Craters.....	Mono.....	N3745-W11900/15 (V 17)	--	---	---	---	Mount Lyell (30')
Mono Lake and Vicinity.....	Tuolumne.....	N3730-W11810/50x70 (U-X 15-18)	100	1914	GS	---	Hawthorne (60')
Monocline Ridge.....	Fresno.....	N3630-W12030/7.5 (P 22 SE)	5, 25	1921	GS	---	Bridgeport (30')
Monsen.....	Tulare.....	N3622.5-W11915/7.5 (U 23 NE)	5	1924	GS	---	Mount Lyell (30')
Monterey.....	San Mateo.....	N3730-W12222.5/7.5 (I 18 SW)	--	---	---	---	Mount Morrison (30')
Monterey Division.....	Monterey.....	N3630-W12145/15 (K 22)	25	1912	GS	WD	White Mountain (30')
Monterey Forest.....	Monterey.....	N3530-W12100/65x60	500	1933	FS	---	Panoche (30')
Montgomery Creek.....	Shasta.....	N4045-W12145/15 (K 5)	--	---	---	---	San Mateo (15')
Montgomery Peak.....	Mono.....	N3745-W11815/15 (Y 17)	--	---	---	---	Lassen Peak (60')
Montpelier.....	Merced.....	N3730-W12037.5/7.5 (P 18 SW)	5	1913	GS	---	Burney (30')
Moon Mountain.....	Stanislaus.....	N3345-W11415/15 (O' 33)	25	1931	GS	---	White Mountain (30')
Mooreville Ridge.....	Riverside.....	N3930-W12100/15 (N 10)	--	---	---	---	Blythe (60')
Morgan Hill.....	Plumas.....	N3700-W12130/15 (L 20)	25	1915	GS	WD	Bidwell Bar (30')
Morgan Valley.....	Santa Clara.....	N3845-W12215/15 (I 13)	--	1916	WD	---	Reiff (15')
Morongo Valley.....	Santa Cruz.....	N3400-W11630/15 (F' 32)	50	1943	GS	---	San Geronio (30')
Morro Hill.....	Yuba, Yolo.....	N3437.5-W11922.5/7.5 (U 30 NW)	50	1943	WD	---	Mount Pinos (30')
Mother Lode Nos. 1 and 2; (see special maps)...	Riverside.....						
	San Bernardino.....						
	Santa Barbara.....						
	Ventura.....						
	Anador.....						
	Calaveras.....						
	Mariposa.....						
	Tuolumne.....						
	Los Angeles.....						
Mount Baden-Powell.....	Fresno.....	N3418-W11742/6 (B' 31)	25	1936	GS	---	Rock Creek (15')
Mount Baxter (unpub.).....	Inyo.....	N3645-W11815/15 (Y 21)	--	---	---	---	San Antonio (15')
Mount Boardman.....	Alameda.....	N3715-W12115/15 (M 19)	50	1940	WD	---	Mount Whitney (30')
	Santa Clara.....						
	Stanislaus.....						

Mount Shafter (unpub.)	Inyo	N3615-W11600/15 (H' 23)	100	1884	GS	Santiago Creek (7½')
Mount Shasta	Siskiyou	N4115-W12205/15 (J 3)	---	---	---	Sawmill Mountain (7½')
Mount Stanford	Fresno	N3715-W11845/15 (W 19)	---	---	---	Topatopa Mountains (7½')
Mount Vaca	Inyo, Mono	N3815-W12200/15 (J 15)	100	1915	WD	Wheeler Springs (7½')
Mount Whitney	Napa	N3630-W11800/30 (Y-Z 21-22)	50	1941	WD	Furnace Creek (60')
	Solano		100	1905	GS	Shasta (60')
	Fresno					Dunsmuir (30')
	Inyo					Mount Goddard (30')
	Tulare					Napa (30')
Mount Whitney	Fresno	N3630-W11815/15 (Y 22)	---	---	---	Suisun (7½')
Mount Wilson	Inyo, Tulare	N3412-W11800/6 (Z 32)	25	1934	GS	Owens Lake and Vicinity, Sp.
	Los Angeles					Owens Valley, Central, Sp.
						Sequoia and General Grant
Mountain Springs	Inyo, Kern,	N3545-W11730/15 (B' 25)	---	---	---	National Parks, Sp.
Canyon (unpub.)	San Bernardino	N3722.5-W12200/7.5 (J 19)	---	---	---	Mount Whitney (30')
Mountain View	Alameda	N3622.5-W12015/7.5 (Q 23 NE)	5	1927	GS	Los Angeles (15')
(unpub.)	San Mateo	N3507.5-W11915/7.5 (U 28 NE)	5, 20	1929	GS	Pasadena (15')
Mouth of Cantua Creek	Santa Clara	N3707.5-W12107.5/7.5 (N 20 NW)	---	---	---	Tujunga (15')
Mouth of Kern	Fresno					Searles Lake (60')
Mule Gulch (unpub.)	Kern					Santa Cruz (30')
Murphy Lake (unpub.)	Merced					Palo Alto (15')
	Santa Clara					Coalinga (30')
	Stanislaus					Joaquin Rocks (15')
	Placer					Elk Hills Oil Field, Sp.
	Sutter					Buena Vista Lake (30')
	Yolo					Pacheco Pass (15')
Murrieta	Riverside	N3845-W12130/15 (L 13)	---	---	---	Knights Landing (7½')
Napa	Contra Costa	N3330-W11700/15 (D' 34)	50	1942	WD	Marcuse (7½')
	Marin	N3800-W12200/30 (I-J 15-16)	100	1899	GS	Nicolaus (7½')
	Solano					Vernon (7½')
	Sonoma					Elsinore (30')
	Yolo					Carquinez (15')
National City	San Diego	N3237.5-W11700/7.5 (D' 38 NE)	25	1939	GS	Mare Island (15')
Needham Mountain	Tulare	N3615-W11830/15 (X 23)	---	---	---	Mount Vaca (15')
(unpub.)						Sonoma (15')
						Suisun (7½')
						San Diego (15')
						Kaweah (30')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Needles (compilation)---	Riverside San Bernardino	N3400-W11400/60 (M'-P' 29-32)	250	---	---	1942	WD	Needles (30') Parker (30') Bannock (15') Black Peak (15') Center Hills (15') Giers Basin (15') Needles (15') Parker (15') Quad X (15') Rice (15') Sawtooth Range (15') Topock (15') Turtle Mountains (15') Vidal (15') Whipple Mountains (15') Needles (60') Needles (15') Sawtooth Range (15') Topock (15') Needles (60') Needles (30') Tejon (30') Liebre (6') Manzana (6') Quail (6') Chico (30') Nevada City, Sp. Smartsville (30')
Needles-----	San Bernardino	N3430-W11415/30 (N'-O' 29-30)	50	1903	GS	---	---	
Needles (provisional)---	San Bernardino	N3445-W11430/15 (N' 29)	--	---	---	---	WD	
Neenach-----	Kern Los Angeles	N3445-W11830/15 (X 29)	100	1943	WD	---	---	
Nelson-----	Butte, Glenn Nevada	N3030-W12145/7.5 (K 10 SE) N3015-W12100/15 (N 11)	5	1910	GS	---	---	
Nevada City-----	Sierra, Yuba Nevada	N3700-W12145/15 (K 20)	25	1916	GS	---	---	
New Almaden (see special maps) (revised by WD as 'Los Gatos')	Santa Clara Santa Cruz	N3807.5-W12122.5/7.5 (M 16 NW) N3615-W12030/15 (P 23)	5	1908	GS	---	---	
New Hope-----	Sacramento San Joaquin	N3615-W12030/15 (P 23)	50	1940	GS	---	---	
New Idria-----	Fresno Monterey San Benito	N3630-W11745/15 (A' 22)	--	---	---	---	---	
New York Butte (unpub.)-----	Inyo	N3730-W12200/7.5 (J 18 SE) N3445-W11630/15 (P' 29) N4145-W12115/15 (M 1)	--	---	---	---	---	
Newark (unpub.)-----	Alameda		--	---	---	---	---	
Newberry (unpub.)-----	San Bernardino		--	---	---	---	---	
Newell (unpub.)-----	Modoc		--	---	---	---	---	
Newhall-----	Siskiyou Los Angeles	N3418-W11830/6 (X 31)	5, 25	1929	GS	---	---	
Newhard-----	Butte, Glenn	N3930-W12152.5/7.5 (K 10 SW)	5	1910	GS	---	---	

Ostrom	-----	Sutter	N3900-W12130/7.5 (L 12 SE)	5	1909	GS	----	----	Marysville (30')
Yuba	-----	Yuba							Marysville (15')
Otay Mesa (unpub.)	-----	San Diego	N3230-W11052.5/7.5 (E' 38 SW)	--	----	----	----	----	Cuyamaca (30')
Otay Mountain	-----	San Diego	N3330-W11045/7.5 (E' 38 SE)	--	----	----	----	----	Jamul (15')
(unpub.)	-----								Cuyamaca (30')
Ottis Creek (unpub.)	-----	Alpine, Mono	N3845-W11930/15 (T 13)	--	----	----	----	----	Jamul (15')
Owens Creek	-----	Mariposa	N3715-W12007.5/7.5 (R 19 SW)	5	1915	GS	----	----	Markleville (30')
Merced	-----	Merced							Indian Gulch (15')
Owens Lake and Vicinity	-----	Inyo	N3550-W11740/50 (Z-B' 23-26)	100	1911	GS	----	----	Ballarat (60')
(not standard	-----								Mount Whitney (30')
quadrangle; scale	-----								Olancha (30')
1:125,000)	-----								
Owens Valley, Central	-----	Inyo	N3640-W11800/50	100	1911	GS	----	----	Ballarat (60')
(not standard quad-	-----	Mono							Bishop (30')
range; scale 1:125,000)	-----								Mount Goddard (30')
Oxalis	-----	Fresno, Merced	N3652.5-W12030/7.5 (P 21 NE)	5	1919	GS	----	----	Mount Whitney (30')
Pacheco Pass	-----	Merced	N3700-W12100/15 (N 20)	50	1918	GS	----	WD	Panoche (30')
Pacifico	-----	Santa Clara							Howard Ranch (7½')
Stanislaus	-----	San Luis Obispo							San Luis Creek (7½')
Packwood	-----	Kern	N3530-W12000/7.5 (R 26 SE)	25	1942	WD	----	----	Cholame (30')
Pacoima	-----	Los Angeles	N3412-W11824/6 (Y 32)	5, 25	1925	GS	----	----	Los Angeles (15')
Pahrump Ranch	-----	Inyo	N3600-W11545/15 (I' 24)	--	----	----	----	----	San Fernando (15')
(unpub.)	-----								Santa Monica (15')
Paige	-----	Tulare	N3607.5-W11922.5/7.5 (U 24 NW)	5	1925	GS	----	----	Las Vegas (60')
Palen Mountains	-----	Riverside	N3345-W11500/15 (I' 33)	50	1943	WD	----	----	Tulare (15')
Palermo	-----	Butte	N3922.5-W12130/7.5 (L 11 NE)	5	1910	GS	----	----	Salton Sea (60')
Palmdale	-----	Los Angeles	N3430-W11806/6 (Z 30)	5, 25	1932	GS	----	----	Marysville (30')
Palm Springs	-----	Riverside	N3345-W11630/15 (F' 33)	100	1942	WD	----	----	Gridley (15')
Palo Alto	-----	San Mateo	N3715-W12200/15 (J 19)	25	1895	GS	----	----	Elizabeth Lake (30')
	-----	Santa Clara		50	1940	WD	----	----	San Jacinto (30')
	-----	Santa Cruz							Santa Cruz (30')
Palo Alto (unpub.)	-----	San Mateo	N3722.5-W12207.5/7.5 (J 19 NW)	--	----	----	----	----	Santa Cruz (30')
	-----	Santa Clara							Palo Alto (15')
Palo Cedro (unpub.)	-----	Shasta	N4030-W12200/15 (J 6)	--	----	----	----	----	Red Bluff (60')
Imperial	-----	Imperial	N3315-W11445/15 (M' 35)	--	----	----	----	----	Redding (30')
Verde Mountains	-----	Riverside							Blythe (60')
(unpub.)	-----	Riverside							
Palomar Mountain	-----	San Diego	N3315-W11645/15 (E' 35)	100	1942	WD	----	----	Ramona (30')

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Panoche-----	Fresno Merced San Benito	N3630-W12030/30 (O-P 21-22)	100	1911	GS	----	----	Ortigalita Peak (15') Panoche Valley (15') Chaney Ranch (7½') Charleston School (7½') Dos Palos (7½') Laguna Seca Ranch (7½') Little Panoche (7½') Monocline Ridge (7½') Ortigalita (7½') Oxalis (7½') Tierra Loma School (7½') Tuney Hills (7½') Wisdom Well (7½') Panoche (30')
Panoche Valley-----	Fresno	N3630-W12045/15 (O 22)	50	1941	GS	----	----	McKittrick (30')
Panorama Hills-----	San Benito	N3507.5-W11937.5/7.5 (T 28 NW)	50	1943	WD	----	----	Lassen Peak (60') Mineral (30') Needles (60') Black Peak (15') Giers Basin (15')
Panther Spring (unpub.)	San Luis Obispo	N4000-W12145/15 (K 8)	--	----	----	----	----	Parker (15')
Parker-----	Riverside San Bernardino	N3400-W11400/30 (O'-P' 31-32)	50	1909	GS	----	----	Whipple Mountains (15')
Parker (provisional)-----	Riverside	N3400-W11415/15 (O' 32)	50	----	----	1943	WD	Needles (60')
Parkfield (unpub.)-----	San Bernardino Fresno Kings Monterey San Luis Obispo	N3545-W12015/15 (Q 25)	--	----	----	----	----	Parker (30') Cholame Hills (7½') Cholame Ranch (7½') Parkfield (7½') The Dark Hole (7½') Cholame (30')
Parkfield-----	Fresno	N3552.5-W12022.5/7.5 (Q 25 NW)	25	1942	WD	----	----	Smartsville (30') Los Angeles (15')
Parks Bar-----	Monterey	N3907.5-W12115/7.5 (M 12 NE)	5, 25	1909	GS	----	----	Alhambra (6')
Pasadena-----	Nevada, Yuba Los Angeles	N3400-W11800/15 (Z 32)	50	1894	GS	----	----	Altadena (6') El Monte (6') Glendale (6') La Crescenta (6') Los Angeles (6') Mount Lowe (6') Mount Wilson (6') Sierra Madre (6')
Paskenta (tactical)-----	Glenn	N3945-W12230/15 (H 9)	--	1918	WD	----	----	

Paso Robles (unpub.)	Monterey San Luis Obispo	N3530-W12030/30 (O-P 25-26)	--	---	---	---	Adelaide (15')
Paso Robles	San Luis Obispo	N3530-W12030/15 (P 26)	50	1918	GS	---	Bradley (15')
Pastoria Creek	Kern	N3452.5-W11845/7.5 (W 29 NE)	50	1943	WD	WD	Paso Robles (15')
Patrick Creek (unpub.)	Del Norte	N4152.5-W12345/7.5 (C 1 NE)	--	---	---	---	San Miguel (15')
Patterson	Stanislaus	N3722.5-W12107.5/7.5 (N 19 NW)	5	1913	GS	---	Tejon (30')
Patterson Mountain (unpub.)	Fresno	N3645-W11900/15 (V 21)	--	---	---	---	Preston Peak (30')
Paulsell	Stanislaus	N3737.5-W12037.5/7.5 (P 18 NW)	5	1913	GS	---	Gasquet (15')
Peacock Point	Butte	N4000-W12115/15 (M 8)	--	---	---	---	Orestimba (15')
Pearland	Plumas, Tehama	N3430-W11800/6 (Z 30)	5, 25	1930	GS	---	Dinuba (30')
Pecwan (unpub.)	Los Angeles	N4115-W12345/7.5 (C 3 SE)	--	---	---	---	Lassen Peak (60')
Pennington	Humboldt	N3915-W12145/7.5 (K 11 SE)	5	1911	GS	---	Elizabeth Lake (30')
Pentland	Butte	N3500-W11915/7.5 (U 28 SE)	5	1931	GS	---	Tectah Creek (15')
Perris	Kern	N3345-W11700/15 (D' 33)	50	1942	WD	---	Hoopa (30')
Pescadero (unpub.)	Riverside	N3707.5-W12222.5/7.5 (I 20 NW)	--	---	---	---	Marysville Buttes and Vicinity, Sp.
Petaluma	San Mateo	N3800-W12230/15 (H 16)	25	1912	GS	---	Marysville (30')
Peters	Marin, Sonoma	N3752.5-W12100/7.5 (N 17 NE)	50	1937	WD	---	Butte Sink (15')
Picacho	San Joaquin	N3300-W11430/15 (N' 36)	50	1912	GS	---	Buena Vista Lake (30')
Picacho Peak	Imperial	N3245-W11430/15 (N' 37)	50	1940	WD	---	Elsinore (30')
Pico	Los Angeles	N3418-W11836/6 (X 31)	25	1936	GS	---	Santa Cruz (30')
Piedras Blancas	San Luis Obispo	N3530-W12115/15 (M 26)	50	1917	GS	---	Año Nuevo (15')
Pilot Creek	Humboldt	N4030-W12330/15 (D 6)	200	1922	WD	---	Blythe (60')
Pilot Knob (compilation)	Trinity	N3500-W11700/30 (C'D' 27-28)	--	---	---	---	Salton Sink, Sp.
Pilot Knob (unpub.)	San Bernardino	N3518-W11700/15 (D' 27)	--	---	---	---	Yuma (60')
Pilot Knob (unpub.)	San Bernardino	N3348-W11545/15 (I' 33)	50	1943	WD	---	Camulos (30')
Pinkham Well	Riverside	N3348-W11545/15 (I' 33)	50	1943	WD	---	Santa Susana (15')
Pinyon Well	Riverside	N3345-W11600/15 (H' 33)	50	1943	WD	---	Searles Lake (60')
Piper Peak (unpub.)	Mono	N3730-W11745/15 (A' 18)	--	---	---	---	Searles Lake (60')
Piru	Ventura	N3415-W11845/15 (W 31)	100	1900	GS	WD	Salton Sea (60')
Pisgah (unpub.)	San Bernardino	N3445-W11615/15 (G' 29)	--	---	---	---	Lida (60')
Pittville (unpub.)	Lassen, Modoc, Shasta,	N4100-W12115/15 (M 4)	--	---	---	---	Silver Peak (30')
Pixley	Siskiyou	N3552.5-W11915/7.5 (U 25 NE)	5	1926	GS	---	Camulos (30')
Placerville	Tulare	N3830-W12030/30 (O-P 13-14)	100	1887	GS	---	Santa Felicia Canyon (6')
	Anador					---	Modoc Lava Bed (60')
	El Dorado					---	Earlhart (15')
						---	American River Survey, Sp.

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Placerville (unpub.)	Amador	N3830-W12045/15 (O 14)	--	---	---	---	---	Placerville (30')
Plainsberg	El Dorado	N3707.5-W12015/7.5 (Q 20 NE)	5	1916	GS	---	---	Athlone (15')
Planada	Madera	N3715-W12015/7.5 (Q 19 SE)	5	1915	GS	---	---	Annapolis (7½')
Plantation	Merced	N3830-W12315/15 (E 14)	100	1915	WD	---	---	Plantation (7½')
Plantation	Sonoma	N3830-W12315/7.5 (E 14 SE)	25	1943	GS	---	---	Stewarts Point (7½')
Plaster City	Imperial	N3245-W11545/15 (I' 37)	25, 50	1943	WD	---	---	Plantation (15')
Pleasant Grove	Placer, Sutter	N3845-W12122.5/7.5 (M 13 SW)	5	1908	GS	---	---	El Centro (30')
Pleasanton	Alameda	N3730-W12145/15 (K 18)	50	1904	GS	1938	WD	Sacramento (30')
Pleito Hills	Kern	N3452.5-W11900/7.5 (V 29 NE)	50	1943	WD	---	---	Markham Ravine (15')
Point Arena	Mendocino	N3845-W12330/15 (D 13)	100	1915	WD	---	---	Mount Pinos (30')
Point Arguello	Santa Barbara	N3430-W12030/15 (P 30)	50	1943	WD	---	---	Guadalupe (30')
Point Bonita (unpub.)	Marin	N3745-W12230/7.5 (H 17 SE)	--	1942	WD	---	---	Tamalpais (15')
Point Conception	San Francisco	N3415-W12015/15 (Q 31)	50	1942	WD	---	---	Lompoc (30')
Point Delgada	Santa Barbara	N4000-W12400/15 (B 8)	100	1916	WD	---	---	San Diego (15')
Point Loma	Humboldt	N3237.5-W11707.5/7.5 (D' 38 NW)	25	1939	GS	---	---	Crescent City (30')
Point Reyes	San Diego	N3800-W12245/15 (G 16)	25	1916	GS	---	---	Guadalupe (30')
Point St. George	Sonoma	N4145-W12400/15 (B 1)	50	1940	WD	---	---	Jamesburg (15')
Point Sal	Del Norte	N3445-W12030/15 (P 29)	50	1942	WD	---	---	Lucia (15')
Point Sur (unpub.)	San Luis Obispo	N3600-W12130/30 (K-L 23-24)	--	---	---	---	---	Point Sur (15')
Point Sur	Monterey	N3615-W12145/15 (K 23)	50	1917	GS	1940	WD	Coalinga (30')
Polvadero Gap	Fresno	N3600-W12000/15 (R 24)	25	---	---	1942	WD	Canoas Creek (7½')
(compilation)	Kings			---	---			Guajarral Hills (7½')
Pomo	Lake	N3915-W12300/15 (F 11)	100	1916	WD	---	---	Huron (7½')
Pomona (unpub.)	Mendocino	N3400-W11730/30 (A-B' 31-32)	--	1943	WD	---	---	La Cima (7½')
	Los Angeles			---	---	---	---	Cucamonga (15')
	Riverside			---	---	---	---	Pomona (15')
	San Bernardino			---	---	---	---	Rock Creek (15')
				---	---	---	---	San Antonio (15')
				---	---	---	---	For 6' coverage, see 15' quadrangles listed above.

Pomona-----	Los Angeles	N3400-W11745/15 (A' 32)	50	1894	GS	----	-----	Azusa (6') Camp Bonita (6') Camp Rincon (6') Chileno Canyon (6') Claremont (6') Covina (6') Glendora (6') La Verne (6') Puente (6') Wasco (15') Modoc Lava Bed (60') Bartle (30') Putah Creek River Survey, Sp. St. Helena (15')
Pond-----	Kern	N3537.5-W11915/7.5 (U 26 NE)	5	1927	GS	----	-----	
Pondosa (unpub.)-----	Shasta	N4100-W12130/15 (L 4)	--	----	----	----	-----	
Pope Valley-----	Siskiyou	N3830-W12215/15 (I 14)	100	1915	WD	----	-----	
Port Harford-----	Napa	N3500-W12045/15 (O 28)	--	----	----	----	-----	
(see Port San Luis)	San Luis Obispo	N3500-W12045/15 (O 28)	50	1895	GS	----	-----	
Port San Luis-----	San Luis Obispo	N3600-W11900/15 (V 24)	50	1939	GS	----	-----	
(originally published as Port Harford)	Tulare		25	----	----	1942	WD	Cairns Corner (7½') Lindsay (7½') Porterville (7½') Woodville (7½') Porterville (15') Sierraville (30') Cuyamaca (30') La Jolla (15') Needles (60') Topock (15') Colusa (15') Caliente (30')
Porterville-----	(compilation)							
Porterville-----	Tulare	N3600-W11900/15 (V 24)	25	----	----	1942	WD	
Portola (unpub.)-----	Tulare	N3600-W11900/7.5 (V 24 SE)	5	1926	GS	----	-----	
Potrero-----	Plumas	N3945-W12015/15 (Q 9)	--	----	----	----	-----	
Poway Valley-----	San Diego	N3230-W11630/15 (P' 38)	50	1942	GS	----	-----	
Powell (unpub.)-----	San Diego	N3252.5-W11700/7.5 (D' 37 NE)	25	1939	GS	----	-----	
	San Bernardino	N3430-W11400/30 (O'-P' 29-30)	--	----	----	----	-----	
Powell Slough-----	Colusa	N3907.5-W12200/7.5 (J 12 NE)	5	1905	GS	----	-----	
Power Plant-----	Kern	N3522.5-W11845/7.5 (W 27 NE)	--	----	----	----	-----	
Pozo-----	(unpub.)							
Pozo Farm-----	San Luis Obispo	N3515-W12015/15 (Q 27)	50	1919	GS	----	-----	
Prado-----	Fresno, Madera	N3652.5-W12022.5/7.5 (Q 21 NW)	5	1919	GS	----	-----	
	Orange	N3352.5-W11737.5/7.5 (B' 33 NW)	5	1933	GS	----	-----	
	Riverside							
	San Bernardino							
Prairie Creek-----	Butte	N3915-W12122.5/7.5 (M 11 SW)	5	1910	GS	----	-----	
	Yuba							
Prattville (unpub.)-----	Butte, Lassen,	N4000-W12100/30 (M-N 7-8)	--	----	----	----	-----	
	Plumas, Shasta,							
	Tehama							
Preston Peak-----	Del Norte	N4130-W12330/30 (C-D 1-2)	100	1915	GS	----	-----	
	Siskiyou							
Preston Peak (unpub.)-----	Del Norte	N4145-W12330/15 (D 1)	--	----	----	----	-----	
	Siskiyou							
Priest Valley-----	Fresno	N3600-W12030/30 (O-P 23-24)	100	1913	GS	----	-----	
	Monterey							
	San Benito							
								Klamath River Survey, Sp. Gasquet (15') Ship Mountain (15') Preston Peak (30') Hernandez Valley (15') New Idria (15') Priest Valley (15') San Ardo (15')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Priest Valley	Fresno	N3600-W12030/15 (P 24)	50	1941	GS	---	---	Priest Valley (30')
Princeton	San Benito	N3922.5-W12200/7.5 (J 11 NE)	5	1904	GS	---	---	Maxwell (15')
Prospect Peak (unpub.)	Glenn	N4030-W12115/15 (M 6)	--	---	---	---	---	Lassen Peak (60')
Puente	Shasta	N3400-W11754/6 (A' 32)	5, 25	1924	---	---	---	Halls Flat (30')
Pulza (unpub.)	Los Angeles	N3945-W12115/15 (M 9)	25	---	---	---	---	Pomona (15')
Pyramid Hills	Butte, Plumas	N3545-W12000/7.5 (R 25 SE)	25	1942	GS	---	---	Bidwell Bar (30')
Pyramid Peak	Kern, Kings	N3830-W12000/30 (Q-R 13-14)	100	1889	WD	---	---	Cholame (30')
Quad X (provisional)	Alpine, Amador	N3415-W11430/15 (N' 31)	100	---	GS	---	---	Needles (60')
Quail	San Bernardino	N3442-W11842/6 (X 30)	25	1933	---	1943	WD	Tejon (30')
Quail Mountains (unpub.)	Los Angeles	N3530-W11645/15 (E' 26)	--	---	---	---	---	Neenach (15')
Quartz Peak (unpub.)	San Bernardino	N3300-W11445/15 (M' 36)	50	---	---	---	---	Lebec (7½')
Quien Sabe	Imperial	N3645-W12100/15 (N 21)	---	1918	GS	---	---	Avawatz Mountains (60')
Quincy (unpub.)	Merced	N3945-W12045/15 (O 9)	25	---	---	---	---	Blythe (60')
Quincy School (unpub.)	San Benito	N3545-W11852.5/7.5 (W 25 SW)	---	1926	---	---	---	Downieville (30')
Rabbit Peak (unpub.)	Santa Clara	N3300-W11600/30 (G'-H' 35-36)	---	---	---	---	---	White River (15')
Raisin	Plumas	N3630-W11952.5/7.5 (S 22 SW)	5	1923	---	---	---	Agua Dulce (15')
Ramona	Kern, Tulare	N3300-W11630/30 (E'-F' 35-36)	100	1901	---	---	---	Barrel Spring (15')
Rancho Santa Fe (unpub.)	Imperial	N3300-W11707.5/7.5 (D' 36 SW)	100	---	---	---	---	Borego (15')
Randsburg	Riverside	N3515-W11730/15 (B' 27)	50	---	---	---	---	Clark Lake (15')
Ravendale (unpub.)	San Diego	N4045-W12015/15 (Q, 5)	5, 25	1930	---	---	---	Palomar Mountain (15')
Ravenna	San Bernardino	N3424-W11812/6 (Z 31)	50	1900	---	---	---	Ramona (15')
Raymond	Lassen	N3700-W11945/15 (S 20)	50	1942	---	---	---	Santa Ysabel (15')
Raynor Creek	Los Angeles	N3707.5-W12000/7.5 (R 20 NE)	5	1915	---	---	---	Warner Springs (15')
	Madera				---	---	---	Ramona (30')
	Mariposa				---	---	---	San Luis Rey (30')
	Merced				---	---	---	Escondido (15')
					---	---	---	Seafair Lake (60')
					---	---	---	Honey Lake (60')
					---	---	---	San Fernando (15')
					---	---	---	Tujunga (15')
					---	---	---	Mariposa (30')
					---	---	---	Paulton (7½')
					---	---	---	Little Table Mountain (7½')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Reyes Peak-----	Ventura	N3437.5-W11915/7.5 (U 30 NE)	50	1942	WD	---	---	Mount Pinos (30')
Reynolds Ranch-----	Kern	N3537.5-W11937.5/7.5 (T 26 NW)	5	1932	GS	---	---	Lost Hills (30')
Rice (provisional)-----	Riverside	N3400-W11445/15 (M' 32)	100	---	---	1943	WD	Hart Station (15')
Richardson Springs-----	San Bernardino	N3945-W12145/15 (K 9)	50	1941	GS	---	---	Needles (60')
	Butte							Chico (30')
	Tehama							Keefers (7½')
Richgrove-----	Kern	N3545-W11900/7.5 (V 25 SE)	5, 25	1925	GS	---	---	Nord (7½')
Richmond (unpub.)-----	Tulare	N3752.5-W12215/7.5 (I 17 NE)	--	---	---	---	---	Singer Creek (7½')
Richs Wells (unpub.)-----	Alameda	N3415-W11615/15 (G' 31)	5	1928	GS	---	---	Terra Bella (15')
Rio Bravo-----	Contra Costa	N3522.5-W11915/7.5 (U 27 NE)	5	1908	GS	---	---	San Francisco (15')
Rio Vista-----	San Bernardino	N3807.5-W12137.5/7.5 (L 16 NW)	5, 10	1913	GS	---	---	Buena Vista Lake (30')
Ripon-----	Kern	N3737.5-W12107.5/7.5 (N 18 SW)	5	1914	GS	---	---	Buttonwillow (15')
Riverbank-----	Sacramento	N3737.5-W12052.5/7.5 (O 18 NW)	5	1924	GS	---	---	Modesto West (15')
Riverdale-----	Solano	N3622.5-W11945/7.5 (S 23 NE)	5	1897	GS	---	---	Modesto East (15')
Riverside-----	Stanislaus	N3345-W11715/15 (C' 33)	25	1942	WD	---	---	Elsinore (30')
Riverside and Vicinity-----	Stanislaus	N3352.5-W11717.5/7.5x12.5 (C' 33 N)	5, 25	1939	GS	---	---	Riverside and Vicinity (7½')
Robbs Peak (unpub.)-----	Kings	N3845-W12015/15 (Q 13)	--	---	---	---	---	Elsinore (15')
Roberts Island (unpub.)-----	El Dorado	N3745-W12115/15 (M 17)	--	---	---	---	---	Riverside (15')
	San Joaquin							Pyramid Peak (30')
								Holt (7½')
								Lathrop (7½')
								Stockton (7½')
								Union Island (7½')
								Camp Bonita (6')
								Camp Rincon (6')
								Chileno Canyon (6')
								Cima Mesa (6')
								Crystal Lake (6')
								Mescal Creek (6')
								Mount Baden-Powell (6')
								Valyerno (6')
								Waterman Canyon (6')
								Sacramento (30')
								Auburn (15')
Rock Creek-----	Los Angeles	N3415-W11745/15 (A' 31)	50	1900	GS	---	---	Trinidad (30')
Rocklin (unpub.)-----	Placer	N3845-W12107.5/7.5 (N 13 SW)	--	---	---	---	---	Trinidad (15')
Rocky Hill-----	Tulare	N3615-W11900/7.5 (V 23 SE)	5, 25	1925	GS	---	---	
Rocky Point (unpub.)-----	Humboldt	N4107.5-W12407.5/7.5 (B 4 NW)	--	---	---	---	---	

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Saddle Point.....	Mendocino	N3900-W12330/15 (D 12)	100	1916	WD	---	---	Alpine Butte (15')
Saddleback Butte.....	Kern	N3430-W11730/30 (A'-B' 29-30)	100	1943	WD	---	---	Kramer (15')
(unpub.)	Los Angeles		--	---	---	---	---	Rogers Lake (15')
	San Bernardino							Shadow Mountains (15')
								For 6' coverage, see 15' quadrangles listed above.
Saint George Reef.....	Del Norte	N4145-W12415/7.5 (A 1 SE)	--	---	---	---	---	Crescent City (30')
(unpub.)								
Saint Helena.....	Lake, Napa	N3830-W12215/15 (I 14)	50	1942	GS	---	---	Pope Valley (15')
Salida.....	San Joaquin	N3737.5-W12100/7.5 (N 18 NE)	5	1913	GS	---	---	Modesto West (15')
Salinas.....	Stanislaus							
Salinas Valley.....	Monterey	N3830-W12130/15 (L 22)	50	1910	GS	1940	WD	Jamesburg (15')
(3 sheets not standard quadrangles; scale 1:31 680)	San Benito	N3630-W12122.5/15 x 7.5 (M 22)	10	1916	GS	---	---	
Salisbury Potrero.....	Santa Barbara	N3445-W11937.5/7.5 (T 29 SW)	50	1942	WD	---	---	Santa Ynez (30')
Salmon Mountain.....	Humboldt	N4100-W12315/15 (E 4)	--	---	---	---	---	Sawyers Bar (30')
(unpub.)	Siskiyou							
Salt Lake.....	Trinity							
Salt Lake (unpub.).....	Kern	N3515-W11745/15 (A' 27)	50	1943	WD	---	---	Searles Lake (60')
Salton (unpub.).....	Imperial	N3300-W11530/30 (I'-J' 35-36)	--	---	---	---	---	Salton Sea (60')
	Riverside							Calipatria (15')
								Durmid (15')
								Frank (15')
								Kane Spring (15')
								Calipatria (15')
								Canyon Spring (15')
								Chuckwalla Mountains (15')
								Cottonwood Springs (15')
								Coxcomb Mountains (15')
								Durmid (15')
								Eagle Tank (15')
								Frank (15')
								Hopkins Well (15')
								Iris (15')
								Iris Pass (15')
								Kane Spring (15')
								Palin Mountains (15')
								Pinkham Well (15')
								Indio, Sp.
								Salton Sink, Sp.
								Agua Dulce (15')
								Calipatria (15')
Salton Sea and Vicinity (not standard quadrangle; scale 1:62,500)	Imperial Riverside	N3305-W11535/30 (H'-J' 34-36)	10	1925	GS	---	---	

Salton Sink ----- (reconnaissance map; scale 1:500,000)	Imperial Riverside San Diego	N3130-W11430/135x105	50	1908	GS	-----	Coachella (15') Cottonwood Spring (15') Dumid (15') Frink (15') Kane Spring (15') Indio, Sp. Salton Sea and Vicinity, Sp. Holtville (30') Yuma (30') Agua Dulce (15') Alamogordo (15') Barrel Springs (15') Brawley (15') Calxico (15') Calipatria (15') Canyon Spring (15') Carrizo Mountain (15') Cottonwood Spring (15') Coyote Wells (15') Dumid (15') Frink (15') Heber (15') Iris Pass (15') Jesumba (15') Kane Spring (15') Midway Well (15') Peacho Peak (15') Plaster City (15') Jackson (30') Boneyard Canyon (6') Camp Bady (6') Camp Bonta (6') Mesal Creek (6') Mount Baden-Powell (6') Swarthout (6') Priest Valley (30') San Ardo (15')
							Arrowhead (7½') Colton (7½') Devore (7½') Fontana (7½')
San Andreas (unpub.) San Antonio	Calaveras Los Angeles San Bernardino	N3800-W12030/15 (P 16) N3415-W11730/15 (B' 31)	50	1900	GS	-----	
San Ardo	Monterey San Benito Monterey	N3600-W12045/15 (O 24)	50	1941	GS	-----	
San Ardo (advance sheet only)		N3600-W12052.5/7.5 (O 24 SW)	5	1912	GS	-----	
San Benito	San Benito	N3630-W12100/15 (N 22)	50	1917	GS	1940	
San Bernardino	Riverside San Bernardino	N3400-W11715/15 (C' 32)	50	1894	GS	1941	
San Clemente Island Sheet 1 (scale 1:25,000)	Los Angeles	N3257.5-W11830/7.5	25	1943	WD		
Sheet 2 (scale 1:25,000)	Los Angeles	N3250-W11827.5/7.5	25	1943	WD		
Sheet 3 (scale 1:25,000)	Los Angeles	N3247.5-W11820/7.5	25	1943	WD		

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
San Diego (unpub.)	San Diego	N3230-W11700/30 (C-D' 37-38)	--	---	---	---	---	La Jolla (15') San Diego (15') Del Mar (7½') La Jolla (7½') La Mesa (7½') National City (7½') Point Loma (7½') Poway Valley (7½') San Ysidro (7½') National City (7½') Point Loma (7½') San Ysidro (7½') Mount Pinos (30') Cuddy Valley (7½') Eagle Rest Peak (7½') Pleito Hills (7½') Sawmill Mountain (7½')
San Diego	San Diego	N3230-W11700/15 (D' 38)	25	1902	GS	---	---	La Jolla (15') San Diego (15') Del Mar (7½') La Jolla (7½') La Mesa (7½') National City (7½') Point Loma (7½') Poway Valley (7½') San Ysidro (7½') National City (7½') Point Loma (7½') San Ysidro (7½')
San Emigdio (unpub.)	Kern Ventura	N3445-W11900/15 (V 29)	--	---	---	---	---	Mount Pinos (30') Cuddy Valley (7½') Eagle Rest Peak (7½') Pleito Hills (7½') Sawmill Mountain (7½')
San Fernando	Los Angeles	N3415-W11815/15 (Y 31)	50	1897	GS	---	---	Humphreys (6') La Crescenta (6') Lang (6') Little Tujunga (6') Pacoima (6') Ravenna (6') Sunland (6') Sylmar (6') Trail Canyon (6')
San Francisco	Alameda Contra Costa	N3745-W12215/15 (I 17)	25 25	1894 1941	GS WD	---	---	
San Francisco North (unpub.)	Marin	N3745-W12237.5/7.5 (I 17 SW)	--	---	---	---	---	San Francisco (15')
San Francisco South (unpub.)	San Francisco San Mateo	N3737.5-W12222.5/7.5 (I 18 NW)	--	---	---	---	---	San Mateo (15')
San Francisco San Geronio	Los Angeles Riverside	N3430-W11824/6 (Y 30) N3400-W11630/30 (E'-F' 31-32)	25 100	1932 1899	GS GS	---	---	Elizabeth Lake (30')
San Gregorio (unpub.)	San Bernardino San Mateo	N3715-W12222.5/7.5 (I 19 SW)	--	---	---	---	---	Santa Cruz (30')
San Guillermo	Ventura	N3437.5-W11907.5/7.5 (V 30 NW)	50	1942	WD	---	---	Half Moon Bay (15')
San Jacinto	Riverside	N3330-W11630/30 (E'-F' 33-34)	100	1898	GS	---	---	Mount Pinos (30') Banning (15') Henet (15')
San Joaquin	Fresno	N3630-W12007.5/7.5 (R 22 SW)	5	1923	GS	---	---	Henet Reservoir (15')
San Jose	Alameda	N3715-W12145/15 (K 19)	25	1895	GS	---	---	Palm Springs (15')
San Jose East (unpub.)	Santa Clara	N3715-W12145/7.5 (K 19 SE)	50	1942	WD	---	---	Kerman (15')
San Jose West (unpub.)	Santa Clara	N3715-W12152.5/7.5 (K 19 SW)	--	---	---	---	---	San Jose (15') San Jose (15')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
San Pedro	Los Angeles	N3330-W11815/15 (Y 34)	25	1894	GS	---	---	San Pedro (30') San Pedro Hills (6') Wilmington (6') San Pedro (30') Redondo (15') San Pedro (15') San Francisco (15')
San Pedro Hills	Los Angeles	N3342-W11818/6 (Y 34)	5	1925	GS	1940	GS	Tamalpais (15') Santa Ynez (30')
San Quentin (unpub.)	Contra Costa Marin	N3752.5-W12237.5/7.5 (I 17 NW)	--	---	---	---	---	Cuyamaca (30') El Cajon (15')
San Rafael (unpub.)	San Francisco	N3752.5-W12230/7.5 (H 17 NE)	100	1942	WD	---	---	San Diego (15')
San Rafael Mountain	Marin	N3430-W11945/15 (S 30)	50	1917	GS	1937	WD	Marysville Buttes and Vicinity, Sp. Marsyville (30') Butte Sink (15') Goodsprings, Sp. Ivanpah (60')
San Simeon	Santa Barbara	N3530-W12100/15 (N 26)	---	---	---	---	---	Corona (30')
San Vicente Creek (unpub.)	San Diego	N3352.5-W11652.5/7.5 (E' 37 NW)	---	---	---	---	---	Tustin (7½')
San Ysidro	San Diego	N3230-W11700/7.5 (D' 38 SE)	25	1941	GS	---	---	Carpinteria (7½')
Sanborn Slough	Colusa Sutter	N3915-W12152.5/7.5 (K 11 SW)	5	1910	GS	---	---	Santa Barbara (7½')
Sandy (unpub.)	Inyo	N3530-W11530/30 (I'-J' 25-26)	---	---	---	---	---	Santa Barbara (15')
Sandy Mush	San Bernardino	N3707.5-W12030/7.5 (P 20 NE)	5	1916	GS	---	---	Newport Beach (7½')
Sanger	Merced	N3637.5-W11930/7.5 (T 22 NE)	5	1920	GS	---	---	San Diego (15')
Santa Ana	Fresno	N3330-W11745/15 (A 34)	25	1894	GS	1900	GS	San Diego (15')
Santa Barbara	Orange	N3415-W11930/15 (T 31)	50	1942	WD	---	---	San Diego (15')
Santa Barbara	Santa Barbara	N3422.5-W11937.5/7.5 (T 31 NW)	50	1901	GS	Reprinted:	---	San Diego (15')
Santa Barbara Island (unpub.)	Santa Barbara Los Angeles	---	50	1943	WD	---	---	San Diego (15')
Santa Barbara National Forest (see Monterey Division)	Los Angeles	---	---	---	---	---	---	San Diego (15')
Santa Catalina Island	Los Angeles	---	---	---	---	---	---	San Diego (15')
Sheet 1 (scale 1:25,000)	---	N3322.5-W11830/7.5	50	1943	WD	---	---	San Diego (15')
Sheet 2 (scale 1:25,000)	---	N3322.5-W11822.5/7.5	50	1943	WD	---	---	San Diego (15')
Sheet 3 (scale 1:25,000)	---	N3315-W11822.5/7.5	50	1943	WD	---	---	San Diego (15')
Sheet 4 (scale 1:25,000)	---	N3317.5-W11815/7.5	50	1943	WD	---	---	San Diego (15')
Santa Cruz	San Mateo Santa Cruz	N3700-W12200/30 (I-J 19-20)	100	1899	GS	---	---	San Diego (15')
Santa Cruz (unpub.)	Santa Cruz	N3652.5-W12200/7.5 (J 21 NE)	--	---	---	---	---	San Diego (15')

Sanctuary	Location	Area (Acres)	Year	Notes
Santa Cruz Island	Santa Barbara	50	1943	WD
Sheet 1 (scale 1:25,000)				
Sheet 2 (scale 1:25,000)		50	1943	WD
Sheet 3 (scale 1:25,000)		50	1943	WD
Sheet 4 (scale 1:25,000)		50	1943	WD
Santa Felicia Canyon	Los Angeles	25	1931	GS
Santa Maria	San Luis Obispo	50	1942	WD
Santa Monica	Santa Barbara	50	1893	GS
Santa Rita	Fresno	50	1902	GS
Santa Rita Bridge	Merced	5	1916	GS
Santa Rosa	Napa, Sonoma	25	1914	GS
Sheet 1 (scale 1:25,000)	Santa Barbara	50	1943	WD
Sheet 2 (scale 1:25,000)		50	1943	WD
Sheet 3 (scale 1:25,000)		50	1943	WD
Sheet 4 (scale 1:25,000)		50	1943	WD
Santa Susana	Los Angeles	50	1900	GS
Camulos (30')				
Piru (15')				
Santa Susana (15')				
Lompoc (30')				
Los Angeles (15')				
Burbank (6')				
Glendale (6')				
Hollywood (6')				
La Crescenta (6')				
Los Angeles (6')				
Pacoima (6')				
Sawtelle (6')				
Sunland (6')				
Van Nuys (6')				
Delta Ranch (7 1/2')				
Sandy Mush (7 1/2')				
Santa Rita Bridge (7 1/2')				
Turner Ranch (7 1/2')				
Camulos (30')				
Castaic (6')				
Chatsworth (6')				
Newhall (6')				
Pico (6')				
Santa Felicia Canyon (6')				
Saugus (6')				
Zelzah (6')				

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Santa Ynez-----	San Luis Obispo Santa Barbara	N3430-W11930/30 (S-T 29-30)	100	1902	GS	---	---	McPherson Peak (15') San Rafael Mountain (15') Big Pine Mountain (7½') Cuyama Ranch (7½') East of Cuyama Ranch (7½') Fox Mountain (7½') Hidreth Peak (7½') Little Pine Mountain (7½') Salisbury Potrero (7½') Strawberry Peak (7½') Ramona (30') Mount Pinos (30')
Santa Ysabel-----	San Diego	N3300-W11630/15 (F' 36)	100	1942	WD	---	---	Corona (30')
Santiago Creek-----	Kern	N3452.5-W11915/7.5 (U 29 NE)	50	1942	WD	---	---	El Toro (7½')
Santiago Peak-----	Ventura	N3330-W11730/15 (B' 34)	50	1942	WD	---	---	Corona (30')
Santiago Peak-----	Orange	N3337.5-W11730/7.5 (B' 34 NE)	--	---	---	---	---	Santiago Peak (15')
Santiago Peak (unpub.)	Riverside	N3337.5-W11730/7.5 (B' 34 NE)	5, 25	1929	GS	---	---	Camules (30')
Saugus-----	Riverside	N3424-W11830/6 (X 31)	5	1926	GS	---	---	Santa Susana (15')
Sausalito School-----	Los Angeles	N3445-W11907.5/7.5 (V 29 SW)	50	1942	WD	---	---	Terra Bella (15')
Sawmill Mountain-----	Tulare	N3400-W11824/6 (Y 32)	5, 25	1923	GS	1931	GS	Mount Pinos (30')
Sawtelle-----	Kern	N3430-W11430/15 (N' 30)	50	---	---	---	---	Los Angeles (15')
Sawtooth Range-----	San Bernardino	N3537.5-W12000/7.5 (B 26 NE)	25	1942	WD	1942	WD	Santa Monica (15')
(provisional)	Kern	N4100-W12300/30 (B-F 3-4)	100	1914	GS	---	---	Needles (30')
Sawtooth Ridge-----	Humboldt	N4115-W12300/15 (F 3)	--	---	---	---	---	Nearby (30')
Sawyers Bar (unpub.)	Trinity	N3822.5-W12137.5/7.5 (L 15 NW)	5	1906	GS	---	---	Cholane (30')
Saxon-----	Siskiyou	N4045-W12230/15 (H 5)	--	---	---	---	---	Klamath River Survey, Sp.
Schnell Mountain-----	Solo	N4107.5-W12352.5/7.5 (C 4 NW)	--	---	---	---	---	Sawyers Bar (30')
(unpub.)	Shasta	N3830-W12100/7.5 (N 14 SE)	--	---	---	---	---	Courtland (15')
Schoolhouse Peak-----	Trinity	N3337.5-W11800/7.5 (Z 34 NE)	5	1932	GS	---	---	Red Bluff (60')
(unpub.)	Humboldt	N3515-W11445/15 (M' 27)	--	---	---	---	---	Weaverville (30')
Scott Ranch (unpub.)	Anador	N3530-W11730/15 (B' 26)	--	---	---	---	---	Hoopa (30')
Seal Beach-----	El Dorado	N3500-W11700/60 (A'-D' 25-28)	100	1912	GS	---	---	Coyote Peak (15')
Searchlight (unpub.)	Sacramento							Sacramento (30')
Searles (unpub.)	Orange							Folsom (15')
Searles Lake-----	San Bernardino							San Pedro (30')
	Kern							Las Bolsas (15')
	San Bernardino							Camp Mohave (60')
	Inyo							Mohave City (30')
	Kern							Searles Lake (60')
								Kramer Borate District, Sp. Castle Butte (15')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Shasta National Forest								
East half (scale 1"=2 miles)	Shasta	N4030-W12110/90x60	200	1933	FS	---	---	
West half (scale 1"=1 mile, approx.)	Siskiyou	N4100-W12210/30x50	100	1929	FS	---	---	
Shasta Valley (19 advance sheets only)	Siskiyou	N4124-W12212/36x30 (H-I 1-3)	--	---	---	---	---	Shasta (60') Dunsmuir (30') Etna (30') MacDoel (30') Yreka (30') Kaiser (30')
Shaver Lake (unpub.)	Fresno	N3700-W11915/15 (U 21)	--	---	---	---	---	
Shaw Peak (unpub.)	Madera	N3700-W11730/30 (A'-B' 19-20)	--	---	---	---	---	Lida (60')
Shedd Canyon	Inyo, Mono	N3530-W12022.5/7.5 (Q 26 SW)	25	1942	WD	---	---	Cholame (30') Telipite (30')
Shell Mountain	San Luis Obispo	N3630-W11845/15 (W 22)	--	---	---	---	---	Ivanpah (60')
Shenandoah Peak (unpub.)	Tulare	N3545-W11530/15 (J' 25)	--	---	---	---	---	Sacramento (30') Markham Ravine (15') Preston Peak (30') Preston Peak (30') Ship Mountain (15') Shasta (60') Dunsmuir (30') Avawatz Mountains (60')
Sheridan (unpub.)	San Bernardino	N3852.5-W12122.5/7.5 (M 13 NW)	5	1908	GS	---	---	Kaiser (30')
Ship Mountain	Placer, Sutter	N4130-W12345/15 (C 2)	50	1942	WD	---	---	Downieville (30')
Ship Mountain (unpub.)	Del Norte	N4137.5-W12345/7.5 (C 2 NE)	--	---	---	---	---	Los Angeles (15') Pasadena (15')
Shoshone Mountain (unpub.)	Del Norte	N4100-W12200/15 (J 4)	--	---	---	---	---	Avawatz Mountains (60')
Shuteye Peak (unpub.)	Shasta	N3545-W11615/15 (G' 25)	--	---	---	---	---	
Sierra Buttes (unpub.)	Siskiyou	N3715-W11915/15 (U 19)	--	---	---	---	---	
Sierra Madre (unpub.)	Inyo, San Bernardino	N3830-W12030/15 (P 10)	--	---	---	---	---	
Sierra Madre	Fresno	N3406-W11800/6 (Z 32)	5, 25	1925	GS	1940	GS	
Sierraville	Madera	N3930-W12000/30 (Q-R 9-10)	100	1890	GS	---	---	
Silurian Hills (unpub.)	Nevada	N3530-W11600/15 (H' 26)	--	---	---	---	---	
Silver Lake (unpub.)	Plumas	N3830-W12000/15 (R 14)	--	---	---	---	---	Avawatz Mountains (60')
Silver Peak (unpub.)	Sierra	N3730-W11730/30 (A'-B' 17-18)	100	1898	GS	---	---	Pyramid Peak (30')
Simmer	Los Angeles	N3515-W11945/15 (S 27)	50	1942	WD	---	---	Lida (60') McKittrick (30')
Singer Creek	Anador	N3952.5-W12152.5/7.5 (K 9 NW)	5	1910	GS	---	---	Chico (30') Richardson Springs (15') Kernville (30') Prescott City (30') Requa (15')
Sirretta Peak (unpub.)	El Dorado	N3545-W11815/15 (Y 25)	--	---	---	---	---	
Sister Rocks (unpub.)	Mono	N4137.5-W12407.5/7.5 (B 2 NW)	--	---	---	---	---	

Sites. Skaggs	Colusa Sonoma	N3915-W12215/7.5 (I 11 SE) N3830-W12300/15 (F 14)	5 100	1904 1915	GS WD	---	---	Lodoga (15') Cazadero (7½') Fort Ross (7½') Skaggs Springs (7½') Tombs Creek (7½')
Skaggs Springs Slater (compilation)	Sonoma Kern	N3837.5-W12300/7.5 (F 14 NE) N3530-W11900/15 (V 26)	25 25	1943 ---	GS ---	---	1942	Skaggs (15') Deepwell Ranch (7½') Famosa (7½') McFarland (7½')
Smartsville	Butte Nevada Placer Yuba	N3900-W12100/30 (M-N 11-12)	100	1886	GS	---	---	North of Oldale (7½') Banner Hill, Sp. Grass Valley, Sp. Nevada City, Sp. Yuba River Survey, Sp. Bangor (15')
Smith River (unpub.)	Del Norte	N4162.5-W12407.5/7.5 (B 1 NW)	--	--	---	---	---	Browns Valley (7½')
Snelling	Merced Stanislaus	N3730-W12022.5/7.5 (Q 18 SW)	5	1915	GS	---	---	Parks Bar (7½')
Soda Lake (unpub.)	Riverside	N3330-W11500/30 (K-L' 33-34)	--	---	---	---	---	Prairie Creek (7½')
Soldier Pass (unpub.)	Inyo Monterey	N3715-W11745/15 (A' 19) N3615-W12115/15 (M 23) N3400-W11842/6 (X 32)	50 25	1913 1929	GS GS	---	1940	Spenceville (7½')
Soldier Pass (unpub.)	Los Angeles	N3400-W11842/6 (X 32)	25	1929	GS	---	---	Wheatland (7½')
Somes Bar (unpub.)	Humboldt Siskiyou	N4115-W12315/15 (E 3)	--	---	---	---	---	Crescent City (30')
Sonoma	Napa	N3815-W12215/15 (I 15)	20	1915	WD	---	---	Point St. George (15')
Sonoma	Mariposa Merced Stanislaus Tuolumne	N3730-W12000/30 (Q-R 17-18)	50 100	1941 1891	WD GS	---	---	Merced Falls (15')
Sonoma (unpub.)	Tuolumne	N3745-W12015/15 (Q 17)	--	---	---	---	---	Salton Sea (60')
Sonoma Pass (unpub.)	Alpine, Mono, Tuolumne	N3815-W11930/15 (T 15)	--	---	---	---	---	Chuckwalla Mountain (15')
South Dos Palos (unpub.)	Fresno Merced	N3645-W12030/15 (P 21)	--	---	---	---	---	Coxcomb Mountains (15')
			--	---	---	---	---	Hopkins Well (15')
			--	---	---	---	---	Palen Mountains (15')
			--	---	---	---	---	Lida (60')
			--	---	---	---	---	Camulos (30')
			--	---	---	---	---	Calabass (15')
			--	---	---	---	---	Triunfo Pass (15')
			--	---	---	---	---	Sawyers Bar (30')
			--	---	---	---	---	Napa (30')
			--	---	---	---	---	Mother Lode District No. 2, Sp.
			--	---	---	---	---	Merced Falls (15')
			--	---	---	---	---	La Grange (7½')
			--	---	---	---	---	Merced Falls (7½')
			--	---	---	---	---	Shelling (7½')
			--	---	---	---	---	Mother Lode District, Sp.
			--	---	---	---	---	Sonora (30')
			--	---	---	---	---	Dardanelles (30')
			--	---	---	---	---	Panoche (30')
			--	---	---	---	---	Dos Palos (7½')
			--	---	---	---	---	Little Panoche (7½')
			--	---	---	---	---	Oxalis (7½')
			--	---	---	---	---	Wisdom Well (7½')

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
South Fork Peak (compilation)	Humboldt	N4015-W12330/15 (D 7)	100	1929	WD	---	---	
Trinity	Modoc	N4145-W12030/15 (P 1)	--	---	---	---	---	Alturas (60')
South Mountain (unpub.)								
Southern California								
No. 1 (scale 1:250,000; reduced from larger scale maps)	Los Angeles	N3330-W11630/60x120 (Y-F' 31-34)	250	1900	GS	---	---	Corona (30') San Geronio (30') San Jacinto (30') San Pedro (30')
Orange	Riverside							
San Bernardino								
Southern California								
No. 2 (scale 1:250,000; reduced from larger scale maps)	Orange	N3230-W11630/60x75 (A-F' 35-38)	250	1902	GS	---	---	Capistrano (30') Cuyamaca (30') Ramona (30') San Luis Rey (30')
Orange	Riverside							
San Diego								
Southern California								
No. 3 (scale 1:250,000; reduced from larger scale maps)	Kern	N3400-W11830/60x135 (P-X 29-32)	250	1904	GS	---	---	Camulos (30') Guadalupe (30') Lompoc (30') Mount Pinos (30') Santa Ynez (30') Tejon (30') Smartsville (30') Colusa (15') Kaweah (30') Kaweah (30')
Kern								
Los Angeles								
San Luis Obispo								
Santa Barbara								
Ventura								
Spenceville	Placer, Yuba	N3900-W12115/7.5 (M 12 SE)	5	1909	GS	---	---	
Spring Valley	Colusa	N3900-W12207.5/7.5 (J 12 SW)	5	1905	GS	---	---	
Springville (unpub.)	Tulare	N3600-W11845/15 (W 24)	--	---	---	---	---	
Springville (unpub.)	Tulare	N3607.5-W11845/7.5 (W 24 NE)	--	---	---	---	---	
Spy Rock (See Covelo)								
Slag (unpub.)	San Bernardino	N3430-W11600/30 (G'-H' 29-30)	--	---	---	---	---	
Starwein Flat (unpub.)	Del Norte	N4122.5-W12352.5/7.5 (C 3 NW)	--	---	---	---	---	
Steele Swamp (unpub.)	Humboldt	N4130-W12030/30 (O-P 1-2)	--	---	---	---	---	
Steele Swamp (unpub.)	Modoc	N4145-W12045/15 (O 1)	--	---	---	---	---	
Stevens	Modoc	N3515-W11907.5/7.5 (V 27 SW)	5	1929	GS	---	---	Hoopa (30') Tetah Creek (15') Alturas (60') Alturas (60') Buena Vista Lake (30') Bakersfield West (15')
Stevenson	Kern	N3715-W12045/7.5 (O 19 SE)	5	1915	GS	---	---	
Stewart Valley (unpub.)	Merced	N3600-W11600/15 (H' 24)	25	1943	GS	---	---	Furnace Creek (60') Plantation (15')
Stewarts Point	Sonoma	N3837.5-W12322.5/7.5 (B 14 NW)	5	1911	GS	---	---	Dinuba (30') Dunlap (15')
Stockton	San Joaquin	N3732.5-W1212.5/7.5 (A 17 NE)	5	1921	GS	---	---	Earlhart (15')
Stokes Mountain	Tulare	N3630-W11907.5/7.5 (V 22 SW)	5	1926	GS	---	---	Ballarat (60')
Stone	Kern, Tulare	N3545-W11915/7.5 (U 25 SE)	5	---	---	---	---	Chatom Ranch (7½')
Stonyford (unpub.)	Colusa, Glenn	N3915-W12230/15 (H 11)	--	---	---	---	---	Kettleman City (7½')
Stovepipe Wells (unpub.)	Inyo	N3630-W11700/15 (D 22)	--	---	---	---	---	Stratford (7½')
Stratford	Fresno	N3600-W11945/15 (S 24)	5	---	---	---	---	Westhaven (7½')
(compilation)	Kings							Stratford (15')
Stratford	Kings	N3607.5-W11945/7.5 (S 24 NE)	5	1926	GS	---	---	

Reprinted in black:

1942

WD

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Tehipite.....	Fresno	N3630-W11830/30 (W-X 21-22)	100	1903	GS	1937	GS	Kings River Survey, Sp. Sequoia and General Grant
Tehipite Dome..... (unpub.)	Fresno	N3645-W11845/15 (W 21)	--	---	---	---	---	National Park, Sp. Kings River Survey, Sp. Sequoia and General Grant
Tejon.....	Kern Los Angeles Ventura	N3430-W11830/30 (W-X 29-30)	100	1901	GS	---	---	National Park, Sp. Tehipite (30') Neenach (15') Black Mountain (7½') Cobblestone Mountain (7½') Devils Heart Peak (7½') Frazier Mountain (7½') Lebec (7½') McDonald Peak (7½') Pastoria Creek (7½') Tecuaya Creek (7½') Beartrap Canyon (6') Black Mountain (6') Gorman (6') Liebre (6') Manzana (6') Quail (6') Red Mountain (6') Redrock Mountain (6') Violin Canyon (6') Warm Spring (6') Whitaker Peak (6') Caliente (30') Tejon (30')
Tejon Hills.....	Kern	N3500-W11845/7.5 (W 28 SE)	5, 25	1931	GS	---	---	Frazier Mountain (7½')
Tejon Pass (unpub.).....	Kern Los Angeles Ventura	N3445-W11845/15 (W 29)	--	---	---	---	---	Lebec (7½') Pastoria Creek (7½') Tecuaya Creek (7½') Gorman (6') Quail (6')
Telescope Peak.....	Inyo	N3600-W11700/30 (C'D' 23-24)	--	---	---	---	---	Ballarat (60')
Telescope Peak..... (unpub.)	Inyo	N3600-W11700/15 (D' 24)	--	---	---	---	---	Ballarat (60')
Temecula.....	Riverside	N3315-W11700/15 (D' 35)	50	1942	WD	---	---	San Luis Rey (30')
Tent Hills.....	San Diego Kings Monterey	N3545-W12007.5/7.5 (R 25 SW)	25	1942	WD	---	---	Cholame (30')
Tepusquet Peak.....	San Luis Obispo	N3445-W12000/15 (R 29)	100	1942	WD	---	---	Lompoc (30')
Terra Bella.....	Santa Barbara	N3545-W11900/15 (V 25)	25	---	---	---	WD	Delano (7½') Ducor (7½') Richgrove (7½') Sausalito School (7½')
(completion)	Kern Tulare							

Terwer Creek (unpub.)	Del Norte	N4130-W12352.5/7.5 (C 2 SW)	--	----	----	----	Preston Peak (30')
Teala	Alameda	N3730-W12130/15 (L 18)	50	1905	GS	1941	Ship Mountain (15')
Thalheim	San Joaquin	N3745-W12052.5/7.5 (O 17 SW)	5	1913	GS	----	Midway (7½')
The Dark Hole	Stanislaus	N3552.5-W12015/7.5 (Q 25 NE)	25	1934	GS	----	Farrington (15')
Thermal (unpub.)	Monterey	N3330-W11600/30 (G'-H' 33-34)	--	----	----	----	Cholame (30')
	Riverside						Coachella (15')
							Edom (15')
Thorpe (unpub.)	Inyo	N3700-W11700/30 (C'-D' 19-20)	--	----	----	----	Pinyon Well (15')
Three Rivers (unpub.)	Tulare	N3622.5-W11832.5/7.5 (W 23 NW)	--	----	----	----	Toro Peak (15')
							Lida (60')
							Sequoia and General Grant
							National Parks, Sp.
							Kaweah (30')
Three Tree Flat	Merced	N3730-W12030/7.5 (P 18 SE)	5	1913	GS	----	Avawatz Mountains (60')
Tiefort Mountains	Stanislaus	N3515-W11630/15 (F' 27)	--	----	----	----	Elizabeth Lake (30')
(unpub.)	San Bernardino						Panoche (30')
Tierra Bonita	Los Angeles	N3436-W11800/6 (Z 30)	5	1930	GS	----	Smartsville (30')
Tierra Loma School	Fresno	N3637.5-W12037.5/7.5 (P 22 NW)	5, 25	1920	GS	----	Brown Valley (7½')
Timbuctoo Bend	Nevada	N3900-W12115/15 (M 12)	--	----	----	----	Parks Bar (7½')
(unpub.)	Placer						Spenceville (7½')
	Sutter						Whitland (7½')
							Ballarat (60')
							Modoc Lava Bed (60')
Tin Mountain (unpub.)	Inyo	N3645-W11715/15 (C' 21)	--	----	----	----	Tulare (15')
Tionesta (unpub.)	Modoc	N4130-W12115/15 (M 2)	--	----	----	----	Marysville Buttes and Vicinity, Sp.
	Siskiyou						Marysville (30')
Tipton	Tulare	N3600-W11915/7.5 (U 24 SE)	5	1925	GS	----	Cern River Survey, Sp.
Tisdale Well	Colusa	N3900-W12145/7.5 (K 12 SE)	5	1910	GS	----	Glennville (15')
	Sutter						White River (15')
	Kern						Woody School (7½')
Tobias Peak	Tulare	N3530-W11830/30 (W-X 25-26)	100	1930	GS	----	Staggs (15')
							Camulos (30')
							Calabasas (15')
							Mount Pinos (30')
							Markleeville (30')
							Needles (60')
							Needles (30')
							Indio, Sp.
							San Pedro (30')
							Redondo (15')
							Acolita (15')
							Chuckwalla Spring (15')
							Iris (15')
							Iris Pass (15')
Tombs Creek	Sonoma	N3837.5-W12307.5/7.5 (F 14 NW)	25	1943	GS	----	
Topanga Canyon	Los Angeles	N3400-W11830/6 (X 32)	5, 25	1925	GS	----	
Topatopa Mountains	Ventura	N3430-W11900/7.5 (V 30 SE)	50	1942	WD	----	
Topaz Lake (unpub.)	Alpine, Mono	N3830-W11930/15 (T 14)	50	----	----	----	
Topeck (provisional)	San Bernardino	N3430-W11415/15 (O' 30)	50	----	WD	1943	
Toro Peak	Riverside	N3330-W11615/15 (G' 34)	100	1942	WD	----	
Torrance	Los Angeles	N3348-W11818/6 (Y 33)	5	1923	GS	1930	
Tortuga (unpub.)	Imperial	N3300-W11500/30 (K'-L' 35-36)	--	----	----	----	
	Riverside						

Name	County	Map index numbers	Contour interval	Survey date	Publishing agency	Revision date	Revision agency	Other quadrangles covering area
Tower Peak (unpub.)	Mono	N3800-W11930/15 (T 16)	5	1928	---	---	---	Dardanelles (30')
Towne Oil Station	Fresno	N3622.5-W12007.5/7.5 (R 23 NW)	5	1912	GS	---	---	Coalinga (30')
Tracy	San Joaquin	N3737.5-W12122.5/7.5 (M 18 NW)	5	1912	GS	---	---	Carbona (15')
Trail Canyon	Los Angeles	N3418-W11812/6 (Z 31)	25	1935	GS	---	---	San Fernando (15')
Tranquillity	Fresno	N3637.5-W12015/7.5 (Q 22 NE)	5	1922	GS	---	---	Tujunga (15')
Traver	Kern, Tulare	N3622.5-W11922.5/7.5 (U 23 NW)	5	1924	GS	---	---	Hawthorne (60')
Trench Canyon	Mono	N3800-W11845/15 (W 16)	---	---	---	---	---	Farmington (15')
Trigo	San Joaquin	N3752.5-W12052.5/7.5 (O 17 NW)	5	1913	GS	---	---	Orick (15')
Trinidad	Stanislaus	N4100-W12400/30 (A-B 3-4)	100	1921	WD	---	---	Trinidad (15')
(compilation)	Humboldt							Trinidad (30')
Trinidad	Humboldt	N4100-W12400/15 (B 4)	50	1942	WD	---	---	Trinidad (30')
Trinidad (unpub.)	Humboldt	N4100-W12407.5/7.5 (B 4 SW)	---	---	---	---	---	Trinidad (15')
Trinity National Forest	Humboldt	N4010-W12240/60x70	200	1933	FS	---	---	
(scale 1"=2 miles)	Shasta							
Triple Divide Peak	Tehama, Trinity	N3630-W11830/15 (X 22)	---	---	---	---	---	Tehipite (30')
(unpub.)	Tulare							
Triunfo Pass	Los Angeles	N3400-W11845/15 (W 32)	100	1900	GS	1942	WD	Camulos (30')
	Ventura							Arroyo Secuit (6')
								Dune Point (6')
								Russell Valley (6')
								Seminole (6')
								Solstice Canyon (6')
								American River Survey, Sp.
Truckee	El Dorado	N3900-W12000/30 (Q-R 11-12)	100	1889	GS	1932	GS	Acton (6')
	Nevada							Alder Creek (6')
	Placer, Sierra							La Crescenta (6')
Tufts Ranch	Fresno	N3637.5-W12022.5/7.5 (Q 22 NW)	5	1920	GS	---	---	Mount Emma (6')
Tujunga	Los Angeles	N3415-W11800/15 (Z 31)	50	1897	GS	---	---	Mount Gleason (6')
								Mount Lowe (6')
								Mount Wilson (6')
								Ravenna (6')
								Trail Canyon (6')
								Lake View School (7½')
								Paige (7½')
								Tipton (7½')
								Tulare (7½')
								Tulare (15')
								Panoche (30')
Tulare (compilation)	Tulare	N3600-W11915/15 (U 24)	25	---	---	1942	WD	
Tulare	Tulare	N3607.5-W11915/7.5 (U 24 NE)	5	1925	GS	---	---	
Tumey Hills	Fresno	N3630-W12037.5/7.5 (P 22 SW)	5, 25	1921	GS	---	---	
	San Benito							

Tuolumne (unpub.)	-----	Mariposa	N3745-W12000/15 (R 17)	--	---	---	Mother Lode District, Sp.
Tupman	-----	Tuolumne Kern	N3515-W11915/7.5 (U 27 SE)	5, 20	1929	GS	Sonora (30')
Turlock	-----	Merced	N3722.5-W12045/7.5 (O 19 NE)	5	1914	GS	Elk Hills Oil Field, Sp.
Turner Ranch	-----	Stanislaus	N3707.5-W12037.5/7.5 (P 20 NW)	5	1916	GS	Buena Vista Lake (30')
Turtle Mountains	-----	Merced	N3415-W11445/15 (M' 31)	100	---	---	Buttonwillow (15')
(provisional)	-----	San Bernardino	N4015-W12200/15 (J 7)	--	---	---	Needles (60')
Tuscan Buttes	-----	Shasta	N3337.5-W11745/7.5 (A' 34 NE)	5	1932	GS	Red Bluff (60')
(unpub.)	-----	Tehama	N3400-W11600/15 (H' 32)	--	---	---	Corona (30')
Tustin	-----	Orange	N4045-W12300/15 (F 5)	--	---	---	Santa Ana (15')
Twenty-nine Palms	-----	Riverside	N3800-W12130/15 (L 16)	--	---	---	Big Bar and Vicinity (30')
(unpub.)	-----	San Bernardino	N3630-W11730/15 (B' 22)	--	---	---	Bouldin (7½')
Twin Sisters	-----	Trinity	N3900-W12300/30 (E-F 11-12)	--	---	---	Isleton (7½')
(unpub.)	-----	Contra Costa	N3900-W12300/30 (E-F 11-12)	--	---	---	Jersey (7½')
Tyler Island (unpub.)	-----	Sacramento	N3630-W11730/15 (B' 22)	--	---	---	Rio Vista (7½')
	-----	San Joaquin	N3900-W12300/30 (E-F 11-12)	--	---	---	Ballarat (60')
	-----	Solano	N3630-W11730/15 (B' 22)	--	---	---	Orrs (15')
Ubechebe Peak (unpub.)	-----	Inyo	N3900-W12300/30 (E-F 11-12)	--	---	---	Pomo (15')
Ukiah (unpub.)	-----	Lake	N3900-W12300/15 (F 12)	100	1916	WD	Ukiah (15')
	-----	Mendocino	N4130-W12315/15 (E 21)	100	1943	WD	Willits (15')
Ukiah	-----	Lake	N3745-W12122.5/7.5 (M 17 SW)	5	1912	GS	Seiad (30')
Ukonom Mountain	-----	Siskiyou	N3815-W12145/15 (K 15)	10	1906	GS	Dixon (7½')
(unpub.)	-----	San Joaquin	N3800-W12045/15 (O 16)	25	1941	GS	Elmira (7½')
Union Island	-----	Solano	N3424-W11748/6 (A' 31)	5, 25	1934	GS	Maine Prairie
Vacaville	-----		N3406-W11824/6 (Y 32)	5, 25	1924	GS	Wolfskill (7½')
	-----		N3900-W12215/15 (I 12)	100	1916	WD	Jackson (30')
Valley Springs	-----	Amador	N3354-W11824/6 (Y 33)	5	1923	GS	Rock Creek (15')
	-----	Calaveras	N3415-W11915/15 (U 31)	50	1902	GS	Los Angeles (15')
	-----	San Joaquin	N3737.5-W12115/7.5 (M 18 NE)	5	1912	GS	Santa Monica (15')
Valermo	-----	Stanislaus	N3845-W12130/7.5 (L 13 SE)	5	1908	GS	Wilbur Springs (15')
Van Nuys	-----	Los Angeles					Fairview (7½')
Venado	-----	Colusa					San Pedro (30')
	-----	Lake					Redondo (15')
Venice	-----	Los Angeles					Carbona (15')

Ventura	-----	Santa Barbara					
	-----	Ventura					
Vernalis	-----	San Joaquin					
	-----	Stanislaus					
Vernon	-----	Sutter, Yolo					

[illegible]

ALPHABETICAL LIST OF SPECIAL MAPS AND RIVER SURVEYS

The U. S. Geological Survey has published a few special maps covering small areas, as well as a number of surveys of rivers which are done on a large scale, and include contour maps of the river channels, profiles, and intensive studies of possible damsites. These maps, because of the irregular area covered, do not fit into the general index system, and so are here appended as a special list.

<i>Name</i>	<i>Description of area covered</i>	<i>Scale</i>	<i>Contour interval</i>	<i>Date</i>	<i>Quadrangles covering area</i>
American River (above Folsom; 8 sheets).	North Fork to Mile 17, Middle Fork to Mile 20, South Fork to Mile 31	1:24,000	10 and 20	1936	Colfax (30') Placerville (30') Sacramento (30') Truckee (30') Auburn (15') Colfax (30') Placerville (30') Sacramento (30') Truckee (30') Colfax (30')
American River Drainage Basin. (Surveyed in cooperation with California Water Commission; 12 sheets)	North, South and Middle Forks above Folsom, Approximate map index No. N-O 13	1:31,680	25	1912	
Banner Hill	Nevada County; lat. $39^{\circ} 13' 50''$ - $39^{\circ} 17' 16''$; long. $120^{\circ} 57' 05''$ - $121^{\circ} 00' 25''$ From a point 3 miles above Esparto to Mile 29. Approximate map index No. J 13	1:14,400	20	1892	
Cache Creek (3 sheets; Sheet 3 is profiles with vertical scale $1'' = 40'$)	Deer Creek from a point 8.3 miles from mouth, North Fork Deer Creek, Mill Creek in vicinity Morgan Springs, Tehama County. Map index No. K-L 7-8	1:31,680	10 and 20	1936	
Deer Creek (3 sheets; Sheet C is profile with vertical scale of $1'' = 100'$)	North Fork Deer Creek, Mill Creek in vicinity Morgan Springs, Tehama County. Map index No. K-L 7-8	1:31,680	20	1932	Lassen Peak (60') Mineral (30') Vina (15')
Eel River (Sheet C profiles vertical scale $1'' = 40'$)	Middle Fork to Mile 34, Black Butte River to Mile 4 and Tributaries. Approximate map index No. F 9-10	1:31,680	25	1925	Corvelo (15') Eden Valley (15')
Grass Valley	Nevada County; latitude $39^{\circ} 10' 22''$ - $39^{\circ} 13' 50''$; longitude $121^{\circ} 01' 25''$ - $121^{\circ} 05' 05''$	1:14,400	20	1891	Smartsville (30')
Kennett Reservoir Site	Shasta County; approximate map index No. I-J 5	1:12,000	20	1934	Red Bluff (60') Redding (30') Calden (30')
Kern River (7 sheets; Sheets F to G profiles with vertical scale $1'' = 100'$)	8 miles above Bakersfield to Mile 53. Approximate map index No. X 26	1:31,680	10 and 20	1934	Tobias Peak (30') Kernville (15')
Keswick Damsite (see Sacramento River)	Approximate map index No. I 6				
Kings River (6 sheets; Sheet 6 profiles with vertical scale $1'' = 100'$)	Piedra to Mile 32, North Fork to Balch Camp, Big Creek to Mile 4. Approximate map index No. U-V 21	1:24,000 1: 2,400	5, 10, 20	1936	Whitipe (30') Tahoe Valley (15')

Klamath River and others (16 sheets; 7 sheets of profiles with vertical scale 1" = 40') Mother Lode No. 1 ----- Mother Lode No. 2 ----- Nevada City ----- Putah Creek (6 sheets; Sheet 6, profiles) -- Sacramento River (6 sheets; 2 sheets of profile Keswick Dam site 1:1,200 and 5 ft. contours) ----- Stanislaus River (2 sheets) ----- Trinity River (4 sheets; miscellaneous dam sites) ----- Upper Narrows Dam site (see Yuba River) - Yosemite Valley ----- Yosemite Valley Floor (advance sheet only) ----- Yuba River (Upper Narrows Dam site; 3 sheets) -----	Other rivers included are Scott River to Mile 22, Trinity River to South Fork Salmon River, South Fork to Grizzly Creek, North Fork of Salmon River to Russian Creek and South Fork of Smith River. Approximate map index No. D-1 1-4 Amador and Calaveras counties, a six-mile N.W. trending belt from Plymouth S.E. to about 1 mile south of Angels Camp Calaveras, Mariposa, Tuolumne counties, a six-mile N.W. trending belt from 1 mile south of Angels Camp S.E. to Merced River Nevada County, latitude 39° 13' 50" 39° 17' 16", longitude 121° 00' 25" 121° 03' 45" From 2 miles above Winters to Middleton. Approximate map index No. H-1 13-14 Red Bluff to Mile 65; Clear Creek to French Gulch Dam site; approximate map index No. I-1 5-8 Knights Ferry to Robinson Ferry; approximate map index No. P 17 Douglas City to Carrville; approximate map index No. G 5-6 Approximate map index No. N 11 Mariposa County; latitude 37° 42' 37° 47' 05"; longitude 119° 29' 119° 43' 40" Mariposa County ----- Approximate map index No. N 11 -----	25 100 100 20 20 10 10 20 25 20 50 2 20	1:48,000 1:63,360 1:63,360 1:14,400 1:31,680 1: 2,400 1: 4,800 1:31,680 1:48,000 1:31,680 1:24,000 1:24,000 1:12,000	1923 1897 1897 1891 1935 1936 1914 1936 1906 1934 1935	MacDoel (30') Preston Peak (30') Saviers Bar (30') Seiad (30') Yreka (30') Jackson (30') Sutter Creek (15') Sonora (30') Colfax (30') Capay (15') Lower Lake (15') St. Helena (15') Red Bluff (60') Redding (30') Weaverville (30') Copperopolis (15') Red Bluff (60') Etna (30') Weaverville (30') Yosemite National Park, Sp. Yosemite (30') Yosemite National Park, Sp. Yosemite Valley, Sp. Yosemite (30') Smartsville (30') Bangor (15')
--	--	--	---	---	---

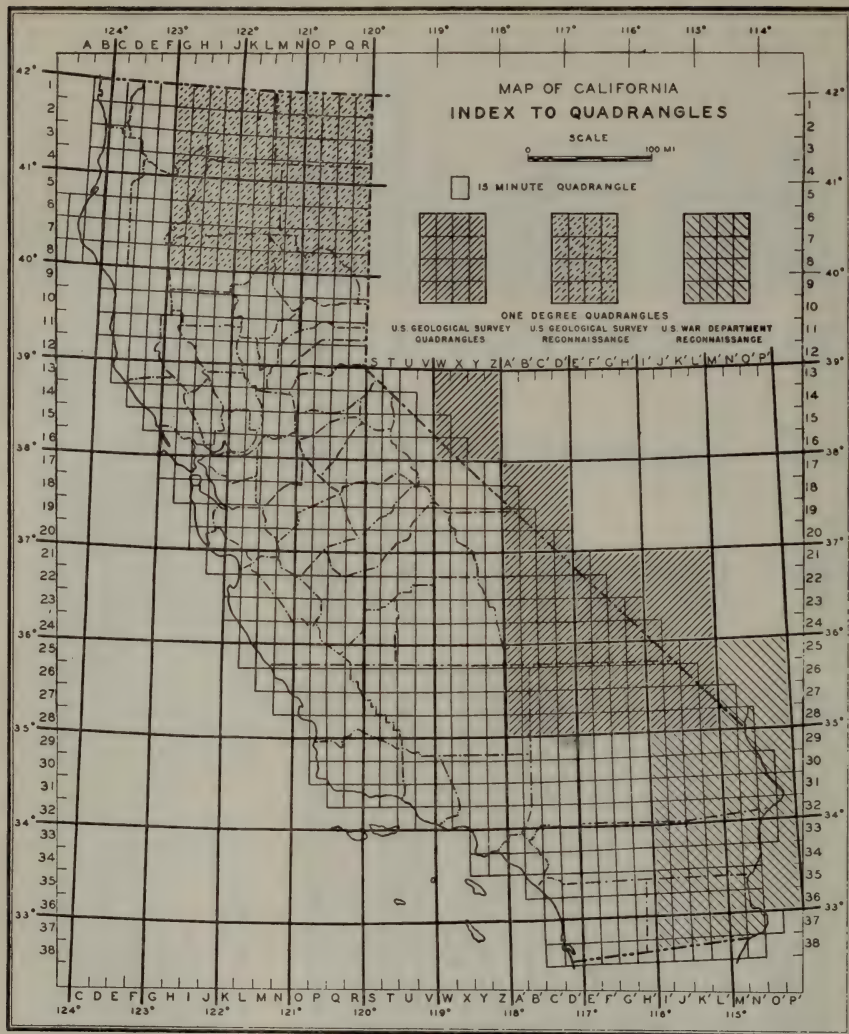


FIG. 1. Index map of California showing areas covered by published 1-degree topographic quadrangles, scale 1:250,000. This index map and those which follow (figs. 1-6) show the State divided into degrees by heavy lines of latitude and longitude, and by lighter lines into 15-minute quadrangles. The 15-minute quadrangles are arbitrarily indexed; alphabetically from left to right, and numerically from top to bottom.

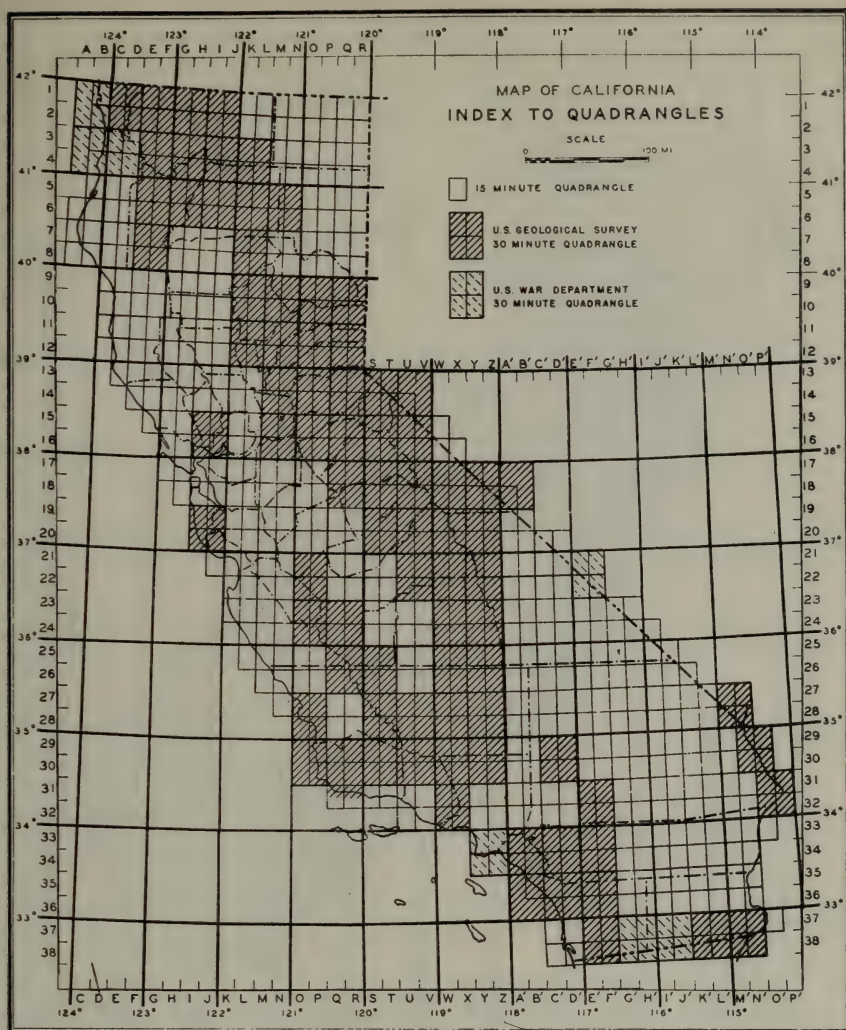


FIG. 2. Index map of California showing areas covered by published 30-minute topographic quadrangles. Most of these quadrangles were mapped by the U. S. Geological Survey; some were mapped by the War Department as indicated.

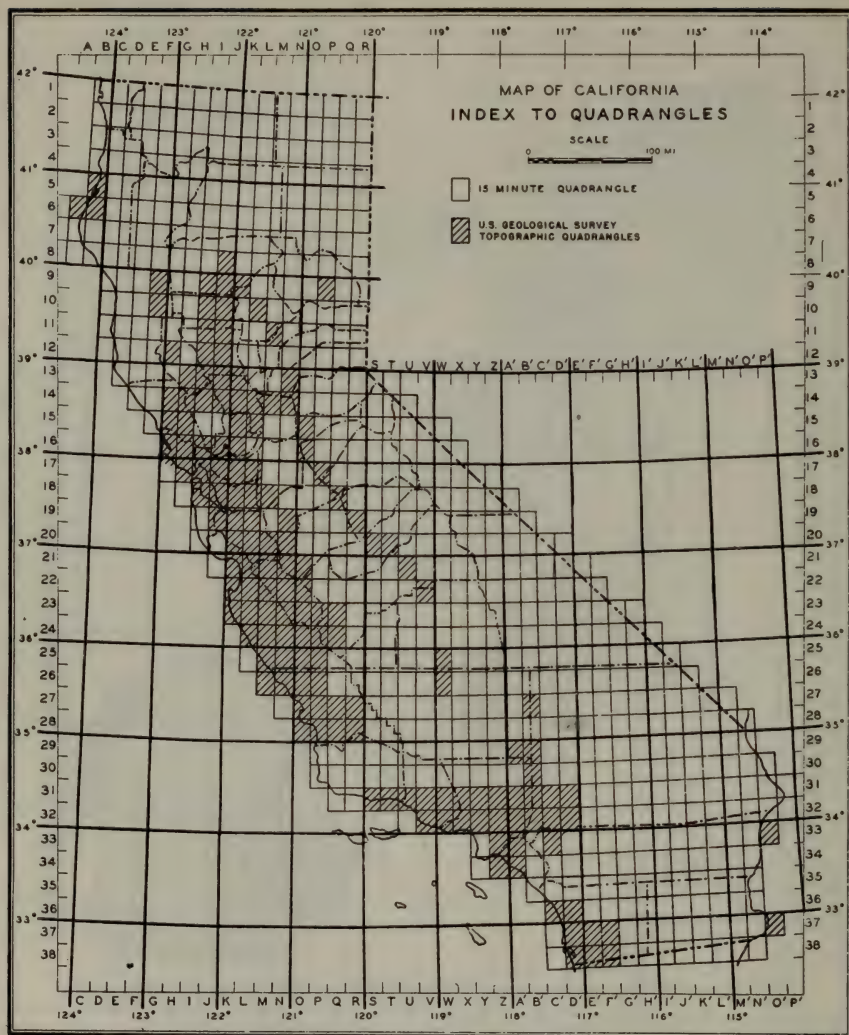


FIG. 3. Index map of California showing areas covered by 15-minute topographic quadrangles, published by the U. S. Geological Survey.

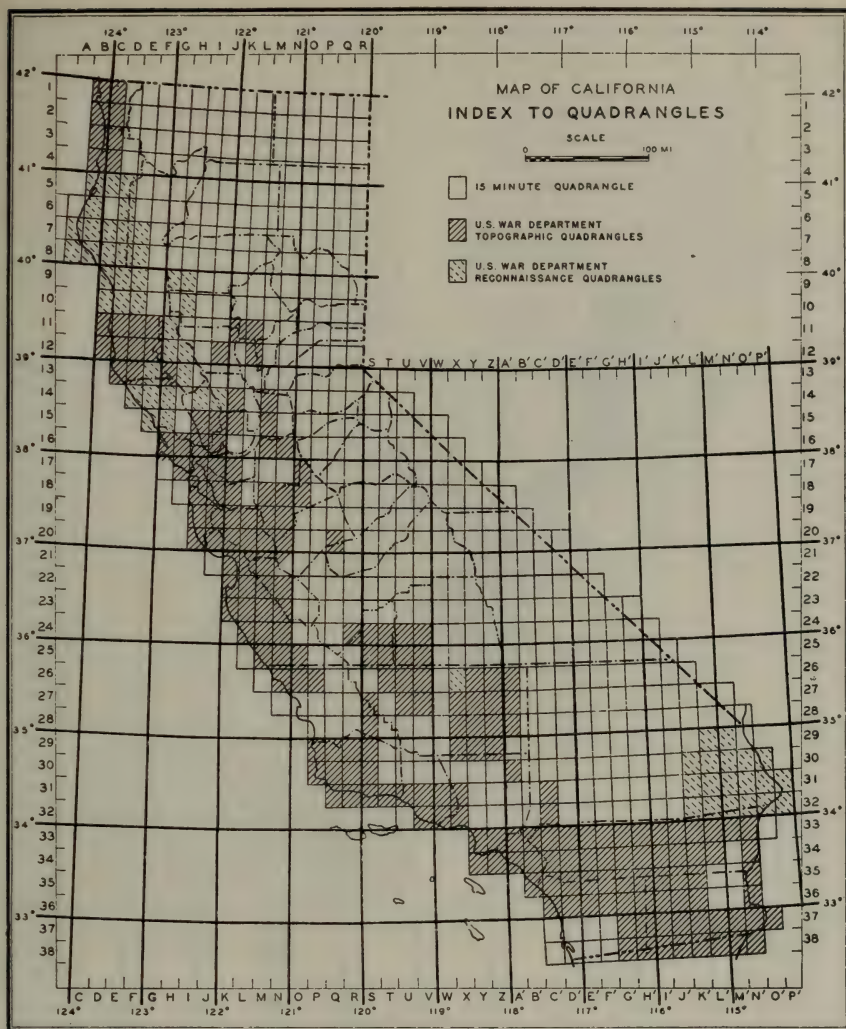


FIG. 4. Index map of California showing area covered by 15-minute quadrangles, published by the U. S. War Department. Those indicated as being reconnaissance include early incomplete mapping in the northwestern part of the State, and maps prepared as enlargements from smaller scale quadrangles in the southeastern part of the State.

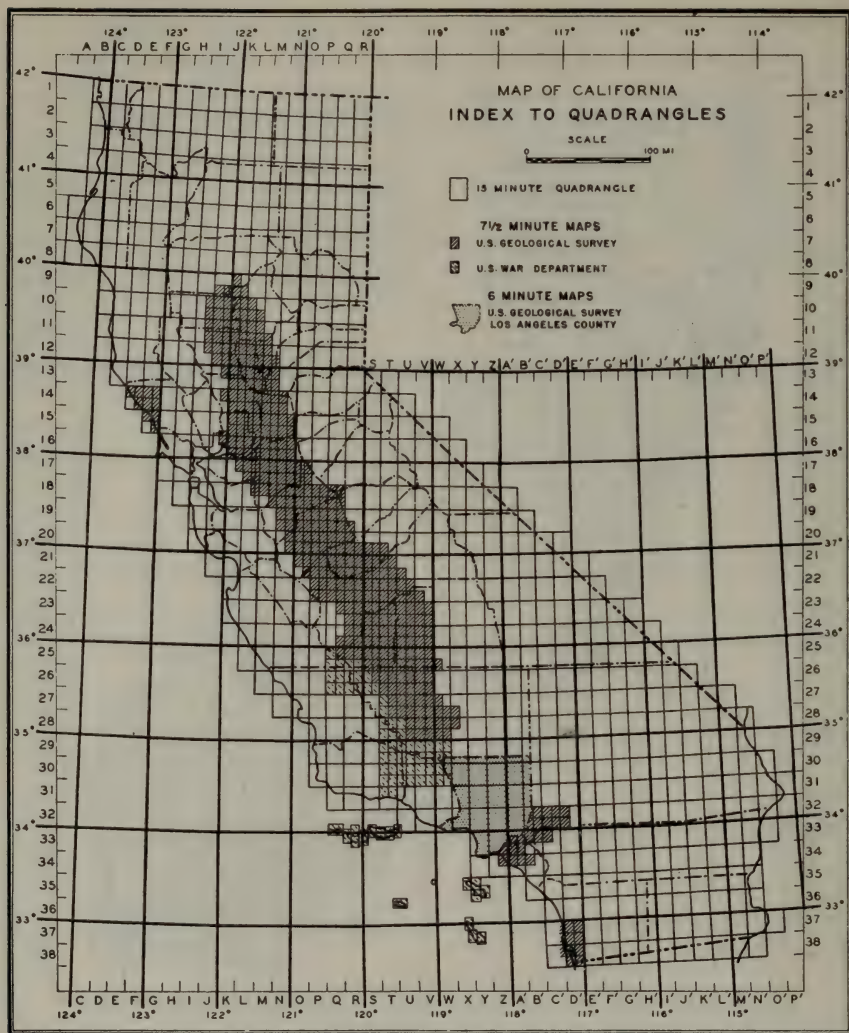


FIG. 5. Index map of California showing area covered by larger scale published quadrangles; namely, 7½-minute sheets, scale 1:31,680 and 6-minute sheets, scale 1:24,000. The 6-minute sheets cover Los Angeles County only, and have not been issued elsewhere.* Some of the 7½-minute sheets have been published by the War Department, but most of them are the work of the U. S. Geological Survey. The large areas shown in the central part of the State cover the agricultural land of the Great Valley of California.

* *Ed. note:* The 6-minute sheets covering Los Angeles County have also been reproduced by the War Department, 30th Engineers, on the scale 1:20,000.

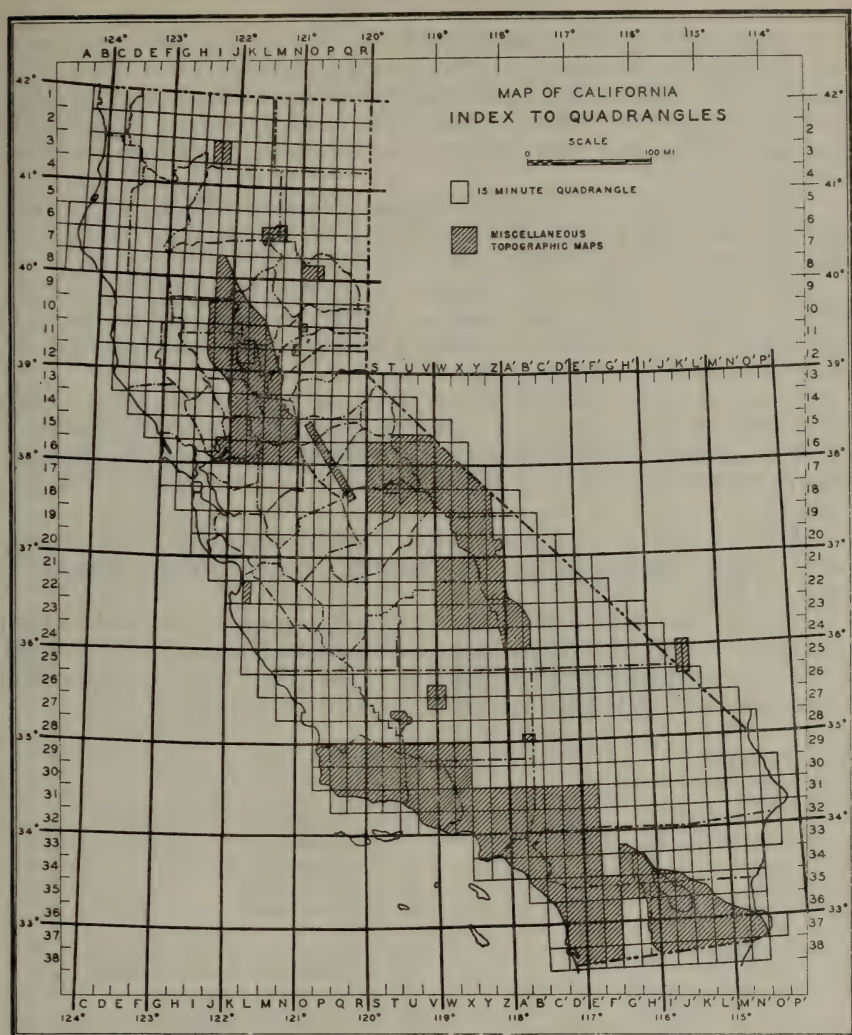


FIG. 6. Index map of California showing published special sheets of the U. S. Geological Survey, for the most part published on large scales; also topographic maps of the National Forests, published by the U. S. Forest Service on the scale of 1 inch equals 2 miles.

INDEX TO UNIT AREAS

Index maps of California shown in this report have been ruled into unit areas of 15 minutes of latitude and longitude, which have been lettered from west to east and numbered from north to south to form a coordinate system. The following list is of 15-minute topographic quadrangles arranged according to this coordinate system by alphabet and by number.

If a 15-minute topographic quadrangle (scale 1:62500 or 1"=1 mi., approx.) has been published for a unit area, the name of the map is listed after the index number, as: *A-6 Ferndale*.

If the word "(unpub.)" appears after a name in the list, as *D-1 Preston Peak (unpub.)*, the area *has not yet been mapped* on the scale of 1:62500, and the name is merely a tentative name adopted for the map yet to come.

If no 15-minute map of a unit area has been made, and no plan name assigned, the name of a published 30-minute (scale 1:125000, or 1"=2 mi., approx.) or 60-minute (scale 1:250000, or 1"=4 mi., approx.) map that covers the area is listed, as *L-9 Chico (30')*, or *0-7 Honey Lake (60')*.

When a unit area has not been mapped topographically on any scale, and no plan name has been assigned, only the index number is listed, as *G-10*.

To find names of published topographic quadrangles (other than 15-minute sheets) that cover any particular unit area, find the name of the unit area in this list; then look up the name in the alphabetical index, and consult the column *Other quadrangles covering area*.

A- 6 Ferndale	D- 6 Pilot Creek
A- 7 Cape Mendocino	D- 7 South Fork Peak
A- 8 Gorda	D- 8 Harris
	D- 9 Cummings
B- 1 Point St. George	D-10 Branscomb
B- 2 Requa	D-11 Glenblair
B- 3 Orick	D-12 Saddle Point
B- 4 Trinidad	D-13 Point Arena
B- 5 Eureka	
B- 6 Fortuna	E- 1 Happy Camp (unpub.)
B- 7 Glenn	E- 2 Ukonom Mountain (unpub.)
B- 8 Point Delgada	E- 3 Somes Bar (unpub.)
	E- 4 Salmon Mountain (unpub.)
C- 1 Gasquet	E- 5 Ironside Mountain (unpub.)
C- 2 Ship Mountain	E- 6 Hyampon (unpub.)
C- 3 Tectah Creek	E- 7 Anada
C- 4 Coyote Peak	E- 8 Island Mountain
C- 5 Blue Lake	E- 9 Covelo
C- 6 Kneeland	E-10 Laytonville
C- 7 Dyerville	E-11 Willits
C- 8 Briceland	E-12 Orrs
C- 9 Kenny	E-13 Ornbau
C-10 Cape Vizcaino	E-14 Plantation
C-11 Fort Bragg	
C-12 Albion	F- 1 Seiad Valley (unpub.)
	F- 2 Marble Mountains (unpub.)
D- 1 Preston Peak (unpub.)	F- 3 Sawyers Bar (unpub.)
D- 2 Dillon Mountain (unpub.)	F- 4 Cecilville (unpub.)
D- 3 Camp Creek (unpub.)	F- 5 Twin Sisters (unpub.)
D- 4 Hoopa (unpub.)	F- 6 Hay Fork (unpub.)
D- 5 China Flat	F- 7 Chanche Lulla Mountain (unpub.)

- F- 8 No. E (unpub.)
 F- 9 Covelo
 F-10 Eden Valley
 F-11 Pomo
 F-12 Ukiah
 F-13 Hopland
 F-14 Skaggs
 F-15 Duncans Mills

 G- 1 Condrey Mountain (unpub.)
 G- 2 Fort Jones (unpub.)
 G- 3 Etna (unpub.)
 G- 4 Yeatapom Peak (unpub.)
 G- 5 Minersville (unpub.)
 G- 6 Weaverville (unpub.)
 G- 7 Beegum Peak (unpub.)
 G- 8 Mount Linn (unpub.)
 G- 9 No. D
 G-10
 G-11 Hullville
 G-12 Lakeport
 G-13 Kelseyville
 G-14 Healdsburg
 G-15 Sebastopol
 G-16 Point Reyes

 H- 1 Hornbrook (unpub.)
 H- 2 Yreka City (unpub.)
 H- 3 China Mountain (unpub.)
 H- 4 Bonanza King (unpub.)
 H- 5 Schnell Mountain (unpub.)
 H- 6 French Gulch (unpub.)
 H- 7 Gas Point (unpub.)
 H- 8 Elim (unpub.)
 H- 9 Paskenta
 H-10 Elk Creek
 H-11
 H-12 Bartlett Springs
 H-13 Lower Lake
 H-14 Calistoga
 H-15 Santa Rosa
 H-16 Petaluma
 H-17 Tamalpais

 I- 1 Copeo (unpub.)
 I- 2 Dwinnell Reservoir (unpub.)
 I- 3 Weed (unpub.)
 I- 4 Dunsmuir (unpub.)
 I- 5 Bayles (unpub.)
 I- 6 Redding (unpub.)
 I- 7 Hooker (unpub.)
 I- 8 Blossom (unpub.)
 I- 9 Flournoy
 I-10 Fruto
 I-11 Lodoga
 I-12 Wilbur Springs
 I-13 Morgan Valley
 I-14 St. Helena
 I-15 Sonoma
 I-16 Mare Island
 I-17 San Francisco
 I-18 San Mateo
 I-19 Halfmoon Bay
 I-20 Año Nuevo

 J- 1 MacDoel (unpub.)
 J- 2 Whaleback (unpub.)
 J- 3 Shasta (unpub.)
 J- 4 Shoeinhorse Mountain (unpub.)
 J- 5 Ballibokka Mountain (unpub.)
 J- 6 Palo Cedro (unpub.)
 J- 7 Tuscan Buttes (unpub.)
 J- 8 Tehama
 J- 9 Vina
 J-10 Willows
 J-11 Maxwell
 J-12 Colusa
 J-13 Rumsey
 J-14 Capay
 J-15 Mount Vaca
 J-16 Carquinez
 J-17 Concord
 J-18 Hayward
 J-19 Palo Alto
 J-20 Ben Lomond

 K- 1 Dorris (unpub.)
 K- 2 Bray (unpub.)
 K- 3 Bartle (unpub.)
 K- 4 Big Bend (unpub.)
 K- 5 Montgomery Creek (unpub.)
 K- 6 Whitmore (unpub.)
 K- 7 Manton (unpub.)
 K- 8 Panther Spring (unpub.)
 K- 9 Richardson Springs
 K-10 Chico (unpub.)
 K-11 Butte Sink
 K-12 West Butte (unpub.)
 K-13 Dunnigan
 K-14 Woodland
 K-15 Vacaville
 K-16 Antioch
 K-17 Mount Diablo
 K-18 Pleasanton
 K-19 San Jose
 K-20 New Almaden
 K-21 Capitola
 K-22 Monterey
 K-23 Point Sur

 L- 1 Dome Mountain (unpub.)
 L- 2 Mount Hoffman (unpub.)
 L- 3 Hambone (unpub.)
 L- 4 Pondsosa (unpub.)
 L- 5 Burney (unpub.)
 L- 6 Manzanita Lake (unpub.)
 L- 7 Lassen Peak (unpub.)
 L- 8 Butte Meadows (unpub.)
 L- 9 Chico (30')
 L-10 Oroville
 L-11 Gridley
 L-12 Marysville
 L-13 Murphy Lake (unpub.)
 L-14 Davisville
 L-15 Courtland
 L-16 Tyler Island (unpub.)
 L-17 Byron
 L-18 Tesla
 L-19 Mount Hamilton

- L-20 Morgan Hill
 L-21 San Juan Bautista
 L-22 Salinas
 L-23 Jamesburg
 L-24 Lucia

 M- 1 Newell (unpub.)
 M- 2 Tionesta (unpub.)
 M- 3 White Horse (unpub.)
 M- 4 Pitville (unpub.)
 M- 5 Jellico (unpub.)
 M- 6 Prospect Peak (unpub.)
 M- 7 Wonderland (unpub.)
 M- 8 Peacock Point (unpub.)
 M- 9 Pulga (unpub.)
 M-10 Big Bend Mountain (unpub.)
 M-11 Bangor
 M-12 Timbucktoo Bend (unpub.)
 M-13 Markham Ravine
 M-14 Fair Oaks
 M-15 Franklin
 M-16 Lodi
 M-17 Roberts Island (unpub.)
 M-18 Carbona
 M-19 Mount Boardman
 M-20 Gilroy Hot Springs
 M-21 Hollister
 M-22 Gonzales
 M-23 Soledad
 M-24 Junipero Serra
 M-25 Cape San Martin
 M-26 Piedras Blancas

 N- 1 Clear Lake Reservoir (unpub.)
 N- 2 Hackamore (unpub.)
 N- 3 Crank Mountain (unpub.)
 N- 4 Bieber (unpub.)
 N- 5 Little Valley (unpub.)
 N- 6 Harvey Mountain (unpub.)
 N- 7 Chester (unpub.)
 N- 8 Almanor (unpub.)
 N- 9 Bucks Lake (unpub.)
 N-10 Mooreville Ridge (unpub.)
 N-11 Nevada City (unpub.)
 N-12 Grass Valley (unpub.)
 N-13 Auburn
 N-14 Folsom
 N-15 Michigan Bar (unpub.)
 N-16 Bellota
 N-17 Collegeville (unpub.)
 N-18 Modesto West
 N-19 Orestimba
 N-20 Pacheco Pass
 N-21 Quien Sabe
 N-22 San Benito
 N-23 Metz
 N-24 King City
 N-25 Bryson
 N-26 San Simeon

 O- 1 Steele Swamp (unpub.)
 O- 2 Jacks Butte (unpub.)
 O- 3 Canby (unpub.)
 O- 4 Adin (unpub.)
 O- 5 Lava Peak (unpub.)
 O- 6 Eagle Lake West (unpub.)

 O- 7 Honey Lake (60')
 O- 8 Greenville (unpub.)
 O- 9 Quincy (unpub.)
 O-10 La Porte (unpub.)
 O-11 Alleghany (unpub.)
 O-12 Giant Gap (unpub.)
 O-13 Georgetown (unpub.)
 O-14 Placerville (unpub.)
 O-15 Sutter Creek
 O-16 Valley Springs
 O-17 Farmington
 O-18 Modesto East
 O-19 Irwin (unpub.)
 O-20 Garzas Creek (unpub.)
 O-21 Ortigalita Peak
 O-22 Panoche Valley
 O-23 Hernandez Valley
 O-24 San Ardo
 O-25 Bradley
 O-26 Adelaida
 O-27 Cayucos
 O-28 Port San Luis

 P- 1 South Mountain (unpub.)
 P- 2 Big Sage Reservoir (unpub.)
 P- 3 Alturas (unpub.)
 P- 4 Likely (unpub.)
 P- 5 Fredonyer Peak (unpub.)
 P- 6 Eagle Lake West (unpub.)
 P- 7 Susanville (unpub.)
 P- 8 Honey Lake (60')
 P- 9 Blairsden
 P-10 Sierra Buttes (unpub.)
 P-11 Emigrant Gap (unpub.)
 P-12 Duncan Peak (unpub.)
 P-13 Saddle Mountain (unpub.)
 P-14 Camino (unpub.)
 P-15 Mokelumne Hill (unpub.)
 P-16 San Andreas (unpub.)
 P-17 Copperopolis
 P-18 Modesto Reservoir (unpub.)
 P-19 Livingston (unpub.)
 P-20 Santa Rita (unpub.)
 P-21 South Dos Palos (unpub.)
 P-22 Indian Peak (unpub.)
 P-23 New Idria
 P-24 Priest Valley
 P-25 San Miguel
 P-26 Paso Robles
 P-27 San Luis Obispo
 P-28 Arroyo Grande
 P-29 Point Sal
 P-30 Point Arguello

 Q- 1 Willow Ranch (unpub.)
 Q- 2 Davis Creek (unpub.)
 Q- 3 Fitzhugh Springs (unpub.)
 Q- 4 Madeline (unpub.)
 Q- 5 Ravendale (unpub.)
 Q- 6 Karlo (unpub.)
 Q- 7 Litchfield (unpub.)
 Q- 8 Milford (unpub.)
 Q- 9 Portola (unpub.)
 Q-10 Calpine (unpub.)
 Q-11 Donner Pass (unpub.)
 Q-12 Granite Chief (unpub.)

- Q-13 Robbs Peak (unpub.)
 Q-14 Leeks Spring Hill (unpub.)
 Q-15 Blue Mountain (unpub.)
 Q-16 Columbia (unpub.)
 Q-17 Sonora (unpub.)
 Q-18 Merced Falls
 Q-19 Yosemite Lake (unpub.)
 Q-20 Athlone
 Q-21 Firebaugh (unpub.)
 Q-22 Ingle (unpub.)
 Q-23 Joaquin Rocks
 Q-24 Coalinga
 Q-25 Parkfield (unpub.)
 Q-26 Shandon (unpub.)
 Q-27 Pozo
 Q-28 Nipomo
 Q-29 Santa Maria
 Q-30 Lompoc
 Q-31 Point Conception

 R- 1 Fort Bidwell (unpub.)
 R- 2 Cedarville (unpub.)
 R- 3 Eagleville (unpub.)
 R- 4 Bearcamp Mountain (unpub.)
 R- 5 Honey Lake (60')
 R- 6 Honey Lake (60')
 R- 7 Wendel (unpub.)
 R- 8 Doyle (unpub.)
 R- 9 Adams Peak (unpub.)
 R-10 Loyalton (unpub.)
 R-11 Martis Valley (unpub.)
 R-12 Tahoe (unpub.)
 R-13 Fallen Leaf Lake (unpub.)
 R-14 Silver Lake (unpub.)
 R-15 Big Meadows (unpub.)
 R-16 Long Barn (unpub.)
 R-17 Tuolumne (unpub.)
 R-18 Coulterville (unpub.)
 R-19 Indian Gulch
 R-20 Fairmead (unpub.)
 R-21 Madera (unpub.)
 R-22 Kerman
 R-23 Delta Farms (unpub.)
 R-24 Polvadero Gap
 R-25 Dudley (unpub.)
 R-26 Orchard Peak (unpub.)
 R-27 La Panza
 R-28 Branch Mountain
 R-29 Tepusquet Peak
 R-30 Los Olivos
 R-31 Gaviota

 S-13 Freel Peak (unpub.)
 S-14 Ebbett Pass (unpub.)
 S-15 Dardanelles Cone (unpub.)
 S-16 Kibbie Ridge (unpub.)
 S-17 Hetch Hetchy West (unpub.)
 S-18 El Portal (unpub.)
 S-19 Mariposa (unpub.)
 S-20 Raymond
 S-21 Figarden (unpub.)
 S-22 Fresno (unpub.)
 S-23 Lemoore (unpub.)
 S-24 Stratford
 S-25 La Rambla

 S-26 Wagonwheel Mountain (unpub.)
 S-27 Simmler
 S-28 Caliente Mountain
 S-29 McPherson Peak
 S-30 San Rafael Mountain
 S-31 Goleta

 T-13 Otts Creek (unpub.)
 T-14 Topaz Lake (unpub.)
 T-15 Sonora Pass (unpub.)
 T-16 Tower Peak (unpub.)
 T-17 Hetch Hetchy East (unpub.)
 T-18 Yosemite Valley (unpub.)
 T-19 White Chief Mountain (unpub.)
 T-20 Millerton Lake
 T-21 Clovis (unpub.)
 T-22 Selma (unpub.)
 T-23 Hanford (unpub.)
 T-24 Corcoran
 T-25 Liberty Farms
 T-26 Hart Station
 T-27 Reward (unpub.)
 T-28 Midway Peak (unpub.)
 T-29 Fox Mountain (unpub.)
 T-30 Big Pine Mountain (unpub.)
 T-31 Santa Barbara

 U-14 Desert Creek Peak (unpub.)
 U-15 Wheeler Peak (unpub.)
 U-16 Matterhorn Peak (unpub.)
 U-17 Mount Conness (unpub.)
 U-18 Merced Peak (unpub.)
 U-19 Shuteye Peak (unpub.)
 U-20 Shaver Lake (unpub.)
 U-21 Watts Valley
 U-22 Dinuba (unpub.)
 U-23 Visalia (unpub.)
 U-24 Tulare
 U-25 Earlimart
 U-26 Wasco
 U-27 Buttonwillow
 U-28 Taft (unpub.)
 U-29 Cuyama Peak (unpub.)
 U-30 Reyes Peak (unpub.)
 U-31 Ventura
 U-32 Anacapa Islands (unpub.)

 V-15 Masonic Mountain (unpub.)
 V-16 Bodie (unpub.)
 V-17 Mono Craters (unpub.)
 V-18 Devils Postpile (unpub.)
 V-19 Sharktooth Peak (unpub.)
 V-20 Huntington Lake (unpub.)
 V-21 Patterson Mountain (unpub.)
 V-22 Dunlap
 V-23 Exeter (unpub.)
 V-24 Porterville
 V-25 Terra Bella
 V-26 Slater
 V-27 Bakersfield West
 V-28 Kern Island (unpub.)
 V-29 San Emigdio (unpub.)
 V-30 Hines Peak (unpub.)
 V-31 Santa Paula
 V-32 Hueneme

- W-15 Aurora (unpub.)
W-16 Trench Canyon (unpub.)
W-17 Cow Track Mountain (unpub.)
W-18 Mount Morgan (unpub.)
W-19 Mount Stanford (unpub.)
W-20 Blackcap Mountain (unpub.)
W-21 Tehitpite Dome (unpub.)
W-22 Shell Mountain (unpub.)
W-23 Kaweah (unpub.)
W-24 Springville (unpub.)
W-25 White River
W-26 Woody
W-27 Bakersfield East (unpub.)
W-28 Comanche Point (unpub.)
W-29 Tejon Pass (unpub.)
W-30 Alamo Mountain (unpub.)
W-31 Piru
W-32 Triunfo Pass
- X-16 Huntoon Valley (unpub.)
X-17 Benton (unpub.)
X-18 Casa Diablo Mountain (unpub.)
X-19 Mount Humphreys (unpub.)
X-20 Mount Goddard (unpub.)
X-21 Marion Peak (unpub.)
X-22 Triple Divide Peak (unpub.)
X-23 Needham Mountain (unpub.)
X-24 Camp Nelson (unpub.)
X-25 California Hot Springs (unpub.)
X-26 Glennville
X-27 Breckenridge Mountain
X-28 Cummings Mountain
X-29 Neenach
X-30 Liebre Mountain (unpub.)
X-31 Santa Susana
X-32 Calabazas
- Y-17 Montgomery Peak (unpub.)
Y-18 White Mountain (unpub.)
Y-19 Bishop (unpub.)
Y-20 Big Pine (unpub.)
Y-21 Mount Baxter (unpub.)
Y-22 Mount Whitney (unpub.)
Y-23 Kern Peak (unpub.)
Y-24 Hockett Peak (unpub.)
Y-25 Sirretta Peak (unpub.)
Y-26 Isabella
Y-27 Emerald Mountain
Y-28 Tehachapi
Y-29 Willow Springs
Y-30 Leonis Valley (unpub.)
Y-31 San Fernando
Y-32 Santa Monica
Y-33 Redondo
Y-34 San Pedro
- Z-17 Davis Mountain (unpub.)
Z-18 McAfee Ranch (unpub.)
Z-19 Blanco Mountain (unpub.)
Z-20 Waucoba Mountain (unpub.)
Z-21 Independence (unpub.)
Z-22 Lone Pine (unpub.)
Z-23 Olancha (unpub.)
Z-24 Monache Mountain (unpub.)
Z-25 Lamont Peak (unpub.)
Z-26 Onyx
Z-27 Cross Mountain
Z-28 Mojave
Z-29 Rosamond
Z-30 Lancaster (unpub.)
Z-31 Tujunga
Z-32 Pasadena
Z-33 Downey
Z-34 Las Bolsas

- A'-18 Piper Peak (unpub.)
 A'-19 Soldier Pass (unpub.)
 A'-20 Waucoba Spring (unpub.)
 A'-21 Ballarat (60')
 A'-22 New York Butte (unpub.)
 A'-23 Keeler (unpub.)
 A'-24 Rose Valley (unpub.)
 A'-25 Little Lake (unpub.)
 A'-26 Inyokern
 A'-27 Saltdale
 A'-28 Castle Butte
 A'-29 Rogers Lake
 A'-30 Alpine Butte
 A'-31 Rock Creek
 A'-32 Pomona
 A'-33 Anaheim
 A'-34 Santa Ana

 B'-19 Magruder Mountain (unpub.)
 B'-20 Last Chance Range (unpub.)
 B'-21 Dry Mountain (unpub.)
 B'-22 Ubehebe Peak (unpub.)
 B'-23 Darwin (unpub.)
 B'-24 Coso Peak (unpub.)
 B'-25 Mountain Springs Canyon (unpub.)
 B'-26 Searles (unpub.)
 B'-27 Randsburg
 B'-28 Johannesburg (unpub.)
 B'-29 Kramer
 B'-30 Shadow Mountains
 B'-31 San Antonio
 B'-32 Cucamonga
 B'-33 Corona
 B'-34 Santiago Peak
 B'-35 San Juan Capistrano

 C'-20 Grapevine Springs (unpub.)
 C'-21 Tin Mountain (unpub.)
 C'-22 Marble Canyon (unpub.)
 C'-23 North Panamint Valley (unpub.)
 C'-24 Argus Range (unpub.)
 C'-25 Argus Peak (unpub.)
 C'-26 Searles Lake (unpub.)
 C'-27 Cuddeback Lake (unpub.)
 C'-28 Fremont Peak (unpub.)
 C'-29 Hawes (unpub.)
 C'-30 Victorville (unpub.)
 C'-31 Hesperia
 C'-32 San Bernardino
 C'-33 Riverside
 C'-34 Lake Elsinore
 C'-35 Margarita Peak
 C'-36 Oceanside
 C'-37 La Jolla
 C'-38 San Diego

 D'-20 Bonnie Claire (unpub.)
 D'-21 Grapevine Mountains (unpub.)
 D'-22 Stovepipe Wells (unpub.)
 D'-23 Emigrant Canyon (unpub.)
 D'-24 Telescope Peak (unpub.)
 D'-25 Manly Peak
 D'-26 Layton Canyon (unpub.)
 D'-27 Pilot Knob (unpub.)
 D'-28 Opal Mountain (unpub.)

 D'-29 Barstow (unpub.)
 D'-30 Granite Mountains (unpub.)
 D'-31 Deep Creek
 D'-32 Redlands
 D'-33 Perris
 D'-34 Murrieta
 D'-35 Temecula
 D'-36 Escondido
 D'-37 La Jolla
 D'-38 San Diego

 E'-21 Bullfrog (unpub.)
 E'-22 Funeral Mountains (unpub.)
 E'-23 Furnace Creek (unpub.)
 E'-24 Bennetts Well (unpub.)
 E'-25 Anvil Spring Canyon (unpub.)
 E'-26 Quail Mountains (unpub.)
 E'-27 Goldstone Lake (unpub.)
 E'-28 Lane Mountain (unpub.)
 E'-29 Daggett (unpub.)
 E'-30 Aztec Spring (unpub.)
 E'-31 Lucerne Valley (unpub.)
 E'-32 Big Bear Lake (unpub.)
 E'-33 Banning
 E'-34 Hemet
 E'-35 Palomar Mountain
 E'-36 Ramona
 E'-37 El Cajon
 E'-38 Jamul

 F'-22 Big Dune (unpub.)
 F'-23 Lees Well (unpub.)
 F'-24 Funeral Peak (unpub.)
 F'-25 Jubilee Pass (unpub.)
 F'-26 Leach Lake (unpub.)
 F'-27 Tiefert Mountains (unpub.)
 F'-28 Alvord Mountain (unpub.)
 F'-29 Newberry (unpub.)
 F'-30 Kane Spring (unpub.)
 F'-31 Old Women Springs (unpub.)
 F'-32 Morongo Valley (unpub.)
 F'-33 Palm Springs
 F'-34 Hemet Reservoir
 F'-35 Warner Springs
 F'-36 Santa Ysabel
 F'-37 Cuyamaca Peak
 F'-38 Potrero

 G'-23 Ash Meadows (unpub.)
 G'-24 Eagle Mountain (unpub.)
 G'-25 Shoshone (unpub.)
 G'-26 Avawatz Pass (unpub.)
 G'-27 Red Pass (unpub.)
 G'-28 Cave Mountain (unpub.)
 G'-29 Pisgah (unpub.)
 G'-30 Lavié (unpub.)
 G'-31 Richs Well (unpub.)
 G'-32 Warrens Well (unpub.)
 G'-33 Edom
 G'-34 Toro Peak
 G'-35 Clark Lake
 G'-36 Borego
 G'-37 Cuyapaie
 G'-38 Campo

- H'-23 Mount Shader (unpub.)
 H'-24 Stewart Valley (unpub.)
 H'-25 Tecopa (unpub.)
 H'-26 Silurian Hills (unpub.)
 H'-27 Baker (unpub.)
 H'-28 Crucero (unpub.)
 H'-29 Hytens Spring (unpub.)
 H'-30 Ludlow (unpub.)
 H'-31
 H'-32 Twentynine Palms (unpub.)
 H'-33 Pinyon Well
 H'-34 Coachella
 H'-35 Agua Dulce
 H'-36 Barrel Spring
 H'-37 Carrizo Mountain
 H'-38 Jacumba

 I'-24 Pahrump Ranch (unpub.)
 I'-25 Tecopa Pass (unpub.)
 I'-26 Kingston Peak (unpub.)
 I'-27 Halloran Spring (unpub.)
 I'-28 Old Dad Mountain (unpub.)
 I'-29 Kerens (unpub.)
 I'-30 Bagdad (unpub.)
 I'-31 Amboy (60')
 I'-32 West of Dale Lake (unpub.)
 I'-33 Pinkham Well
 I'-34 Cottonwood Spring
 I'-35 Durmid
 I'-36 Kane Spring
 I'-37 Plaster City
 I'-38 Coyote Wells

 J'-25 Shenandoah Peak (unpub.)
 J'-26 Clark Mountain (unpub.)
 J'-27 Mescal Range (unpub.)
 J'-28 Kelso (unpub.)
 J'-29 Flynn (unpub.)
 J'-30 Cadiz (unpub.)
 J'-31 Amboy (60')
 J'-32 Dale Lake (unpub.)
 J'-33 Eagle Tank
 J'-34 Canyon Spring
 J'-35 Frink
 J'-36 Calipatria
 J'-37 Brawley
 J'-38 Heber

 K'-26 Calada (unpub.)
 K'-27 Ivanpah (unpub.)
 K'-28 Mid Hills (unpub.)
 K'-29 Amboy (60')
 K'-30 Danby
 K'-31 Cadiz Lake
 K'-32 Cadiz Valley

 K'-33 Coxcomb Mountains
 K'-34 Chuckwalla Mountains
 K'-35 Iris Pass
 K'-36 Iris
 K'-37 Alamorio
 K'-38 Calexico

 L'-27 Crescent Peak (unpub.)
 L'-28 Lanfair Valley (unpub.)
 L'-29 Fenner
 L'-30 Essex
 L'-31 Milligan
 L'-32 Iron Mountains
 L'-33 Palen Mountains
 L'-34 Hopkins Well
 L'-35 Chuckwalla Spring (unpub.)
 L'-36 Acolita (unpub.)
 L'-37 Glamis
 L'-38 Midway Well

 M'-27 Searchlight (unpub.)
 M'-28 Mohave City (30')
 M'-29 Bannock
 M'-30 Center Hills
 M'-31 Turtle Mountains
 M'-32 Rice
 M'-33 Midland
 M'-34 McCoy Spring (unpub.)
 M'-35 Palo Verde Mountains (unpub.)
 M'-36 Quartz Peak (unpub.)
 M'-37 Ogilby
 M'-38 Grays Well

 N'-28 Mohave City (unpub.)
 N'-29 Needles
 N'-30 Sawtooth Range
 N'-31 Quad X
 N'-32 Vidal
 N'-33 Big Maria Mountains
 N'-34 Ehrenberg
 N'-35 Cibola
 N'-36 Picacho
 N'-37 Picacho Peak
 N'-38 Yuma

 O'-30 Topock
 O'-31 Whipple Mountains
 O'-32 Parker
 O'-33 Moon Mountain
 O'-34 Dome Rock Mountains
 O'-37 Laguna

 P'-31 Giers Basin
 P'-32 Black Peak

LIST OF QUADRANGLE MAPS ARRANGED BY LATITUDE AND LONGITUDE

An index system based on latitude and longitude, applicable to maps of any part of the world, was established by the U. S. Geological Survey and adopted by the War Department and other Government agencies. It is explained in detail in U. S. Geological Survey, Topographic Branch, Technical Memo. 39 (mimeographed), July 11, 1940. The index symbol for each map consists of the latitude and longitude of the point on the map nearest the equator and Greenwich meridian, plus the extent of the area in minutes of latitude and longitude. In the following index, published topographic quadrangles of California are listed according to this system, from south to north and east to west. On maps that lie within the boundaries of California, the point nearest the equator and Greenwich meridian is the southeast corner, since the whole of the State lies within north latitudes and west longitudes. For the same reason, the letters preceding latitude and longitude numbers are always N and W respectively.

<i>Index Number</i>		<i>Map Name</i>	
<i>Coordinates, S.E. corner of map</i>		<i>Minutes of latitude and longitude covered by map</i>	
<i>Latitude North</i>	<i>Longitude West</i>		
N3200	W11400	60	Yuma
	11500	60	El Centro
N3230	W11430	30	Yuma
		15	Yuma
	11445	15	Grays Well
	11500	30	Holtville
		15	Midway Well
	11515	15	Calexico
	11530	30	El Centro
		15	Heber
	11545	15	Coyote Wells
	11600	30	Carrizo
		15	Jacumba
	11615	15	Campo
	11630	30	Cuyamaca
		15	Potrero
	11645	15	Jamul
	11700	15	San Diego
		7.5	San Ysidro
N3237.5	W11700	7.5	National City
	11700.5	7.5	Point Loma
N3245	W11415	7.5	Laguna
	11430	15	Picacho Peak
	11445	15	Ogilby
	11500	15	Glamis
	11515	15	Alamorio
	11530	15	Brawley
	11545	15	Plaster City
	11600	15	Carrizo Mountain
	11615	15	Cuyapaipa
	11630	15	Cuyamaca Peak
	11645	15	El Cajon
	11700	15	La Jolla
		7.5	La Mesa
	11707.5	7.5	La Jolla
N3247.5	W11820	7.5	San Clemente Island (sheet 3)
N3250	W11827.5	7.5	San Clemente Island (sheet 2)
N3252.5	W11700	7.5	Poway Valley
	11707.5	7.5	Del Mar
N3257.5	W11830	7.5	San Clemente Island (sheet 1)
N3300	W11400	60	Blythe
	11430	15	Picacho
	11500	60	Salton Sea
	11515	15	Iris
	11530	15	Calipatria
	11545	15	Kane Spring
	11600	15	Barrel Spring

<i>Index Number</i>		<i>Map Name</i>	
<i>Coordinates, S.E. corner of map</i>		<i>Minutes of latitude and longitude covered by map</i>	
<i>Latitude North</i>	<i>Longitude West</i>		
	11615	15	Borego
	11630	30	Ramona
		15	Santa Ysabel
	11645	15	Ramona
	11700	30	San Luis Rey
		15	Escondido
	11715	15	Oceanside
	11730	30	Capistrano
N3312	W11925.5	6 x 9.5	San Nicolas Island
N3315	W11430	15	Cibola
	11515	15	Iris Pass
	11530	15	Frink
	11545	15	Durmid
	11600	15	Agua Dulce
	11615	15	Clark Lake
	11630	15	Warner Springs
	11645	15	Palomar Mountain
	11700	15	Temecula
	11715	15	Margarita Peak
	11730	15	San Juan Capistrano
	11822.5	7.5	Santa Catalina Island (sheet 3)
N3317.5	W11815	7.5	Santa Catalina Island (sheet 4)
N3322.5	W11822.5	7.5	Santa Catalina Island (sheet 2)
	11830	7.5	Santa Catalina Island (sheet 1)
N3330	W11415	15	Dome Rock Mountains
	11430	15	Ehrenberg
	11500	15	Hopkins Well
	11515	15	Chuckwalla Mountains
	11530	15	Canyon Spring
	11545	15	Cottonwood Spring
	11600	15	Coachella
	11615	15	Toro Peak
	11630	30	San Jacinto
		15	Hemet Reservoir
	11645	15	Hemet
	11700	30	Elsinore
		15	Murrieta
	11715	15	Lake Elsinore
	11730	30	Corona
		15	Santiago Peak
	11745	15	Santa Ana
	11800	30	San Pedro
		15	Las Bolsas
	11815	15	San Pedro
N3335	W11752.5	7.5	Newport Beach
N3337.5	W11737.5	7.5	El Toro
	11745	7.5	Tustin
	11800	7.5	Seal Beach
N3342	W11812	6	Wilmington
	11818	6 x 8	San Pedro Hills
N3344	W11805	4 x 7	Long Beach
N3345	W11415	15	Moon Mountain
	11430	15	Big Maria Mountains
	11445	15	Midland
	11500	15	Palen Mountains
	11515	15	Coxcomb Mountains
	11530	15	Eagle Tank
	11545	15	Pinkham Well
	11600	15	Pinyon Well
	11615	15	Edom
	11630	15	Palm Springs
	11645	15	Banning
	11700	15	Perris
	11715	15	Riverside
	11730	15	Corona
	11745	15	Anaheim
		7.5	Orange
	11752.5	7.5	Garden Grove
	11800	15	Downey
		7.5	Los Alamitos
N3348	11815	15	Redondo
	W11800	6	Artesia
	11806	6	Clearwater
	11812	6	Compton
	11818	6 x 8	Torrance
N3350	W12002.5	7.5	Santa Rosa Island (sheet 3)

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3352.5	W11717	7.5 x 9.5	Riverside and vicinity
	11730	7.5	Corona and vicinity
	11737.5	7.5	Prado
	11745	7.5	Olinda
	11752.5	7.5	Coyote Hills
N3353.5	W11955	7.5	Santa Rosa Island (sheet 4)
	12010	7.5	Santa Rosa Island (sheet 1)
N3354	W11748	6	La Brea
	11754	6	La Habra
	11800	6	Whittier
	11806	6	Bell
	11812	6	Watts
	11818	6	Inglewood
	11824	6	Venice
N3356.5	W11935	7.5	Santa Cruz Island (sheet 3)
	11942.5	7.5	Santa Cruz Island (sheet 2)
N3357.5	W11927.5	7.5	Santa Cruz Island (sheet 4)
	11950	7.5	Santa Cruz Island (sheet 1)
	12002.5	7.5	Santa Rosa Island (sheet 2)
N3400	W11400	60	Needles
		30	Parker
		15	Black Peak
	11415	15	Parker
	11430	15	Vidal
	11445	15	Rice
	11500	60	Amboy
		15	Iron Mountains
	11515	15	Cadiz Valley
	11630	30	San Geronio
	11700	15	Redlands
	11706	7.5 x 9	Redlands and vicinity
	11715	15	San Bernardino
		7.5	Colton
	11722.5	7.5	Fontana
	11730	15	Cucamonga
		7.5	Guasti and vicinity
	11737.5	7.5	Ontario and vicinity
	11742	6	Claremont
	11745	15	Pomona
	11748	6	Covina
	11754	6	Puente
	11800	15	Pasadena
		6	El Monte
	11806	6	Alhambra
	11812	6	Los Angeles
	11815	15	Santa Monica
	11818	6	Hollywood
	11824	6	Sawtelle
	11830	30	Camulos
		15	Calabasas
		6	Topanga Canyon
	11836	6	Las Flores
	11842	6	Solstice Canyon
	11845	15	Triunfo Pass
	11848	6	Dume Point
	11854	6	Arroyo Sequit
	11900	15	Hueneme
N3406	W11736	6	Evey Canyon
	11742	6	La Verne
	11748	6	Glendora
	11754	6	Azusa
	11800	6	Sierra Madre
	11806	6	Altadena
	11812	6	Glendale
	11818	6	Burbank
	11824	6	Van Nuys
	11830	6	Reseda
	11836	6	Dry Canyon
	11842	6	Seminole
	11848	6	Russell Valley
N3407.5	W11715	7.5	Arrowhead
	11722.5	7.5	Devore
N3412	W11736	6	Camp Baldy
	11742	6	Camp Bonita
	11748	6	Camp Rincon
	11754	6	Chileno Canyon
	11800	6	Mount Wilson
	11806	6	Mount Lowe
	11812	6	La Crescenta

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3415	11818	6	Sunland
	11824	6	Pacoima
	11830	6	Zelzah
	11836	6	Chatsworth
	W11400	15	Giers Basin
	11415	15	Whipple Mountains
	11430	15	Quad. X
	11445	15	Turtle Mountains
	11500	15	Milligan
	11515	15	Cadiz Lake
	11700	15	Deep Creek
	11715	15	Hesperia
	11730	15	San Antonio
	11745	15	Rock Creek
	11800	15	Tujunga
	11815	15	San Fernando
	11830	15	Santa Susana
	11845	15	Piru
	11900	15	Santa Paula
	11915	15	Ventura
N3418	11930	15	Santa Barbara
	11945	15	Goleta
	12000	15	Gaviota
	12015	15	Point Conception
	W11736	6	Swarthout
	11742	6	Mount Baden-Powell
	11748	6	Crystal Lake
	11754	6	Waterman Mountain
	11800	6	Alder Creek
	11806	6	Mount Gleason
	11812	6	Trail Canyon
	11818	6	Little Tujunga
N3422.5	11824	6	Sylmar
	11830	6	Newhall
	11836	6	Pico
	W11930	7.5	Carpenteria
	11937.5	7.5	Santa Barbara
N3424	W11736	6	Boneyard Canyon
	11742	6	Mescal Creek
	11748	6	Valyermo
	11754	6	Cima Mesa
	11800	6	Mount Emma
	11806	6	Acton
	11812	6	Ravenna
	11818	6	Lang
	11824	6	Humphreys
	11830	6	Saugus
N3427.5	11836	6	Castaic
	11842	6	Santa Felicia Canyon
	W12000	32.5 x 30	Lompoc
N3430	W11415	30	Needles
		15	Topock
	11430	15	Sawtooth Range
	11445	15	Center Hills
	11500	15	Essex
	11515	15	Danby
	11700	30	Barstow
	11730	15	Shadow Mountains
	11736	6	Angle
	11742	6	Black Butte
	11745	15	Alpine Butte
	11748	6	Llano
	11754	6	Little Rock
	11800	30	Elizabeth Lake
		6	Pearland
	11806	6	Palmdale
	11812	6	Red Rover
	11818	6	Bouquet Reservoir
	11824	6	San Francisquito
	11830	30	Tejon
		6	Red Mountain
	11836	6	Violin Canyon
	11842	6	Whitaker Peak
	11845	7.5	Cobblestone Mountain
	11852.5	7.5	Devils Heart Peak
	11900	30	Mount Pinos
		7.5	Topatopa Mountains
	11907.5	7.5	Lion Canyon
	11915	7.5	Wheeler Springs

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
	11922.5	7.5	Old Man Mountain
	11930	30	Santa Ynez
		7.5	Hildreth Peak
	11937.5	7.5	Little Pine Mountain
	11945	15	San Rafael Mountain
	12000	15	Los Olivos
	12015	15	Lompoc
	12030	30	Guadalupe
		15	Point Arguello
N3436	W11736	6	El Mirage
	11742	6	Wilsona
	11748	6	Lovejoy Springs
	11754	6	West Alpine Butte
	11800	6	Tierra Bonita
	11806	6	Lancaster
	11812	6	Del Sur
	11818	6	Lake
	11824	6	Hughes Lake
	11830	6	Warm Spring
	11836	6	Red Rock Mountain
	11842	6	Beartrap Canyon
	11848	6	Black Mountain
N3437.5	W11845	7.5	Black Mountain
	11852.5	7.5	McDonald Peak
	11900	7.5	Lockwood Valley
	11907.5	7.5	San Guillermo
	11915	7.5	Reyes Peak
	11922.5	7.5	Morro Hill
	11930	7.5	Strawberry Peak
	11937.5	7.5	Big Pine Mountain
N3442	W11736	6*	Adobe
	11742	6	Hi Vista
	11748	6	Joshua
	11754	6	Casa Desierta
	11800	6	Roosevelt School
	11806	6	Oban
	11812	6	Esperanza School
	11818	6	Little Buttes
	11824	6	Fairmont
	11830	6	Manzana
	11836	6	Liebre
	11842	6	Quail
	11848	6*	Gorman
N3445	W11430	15	Needles
	11445	15	Bannock
	11500	15	Fenner
	11730	15	Kramer
	11745	15	Rogers Lake
	11800	15	Rosamond
	11815	15	Willow Springs
	11830	15	Neenach
	11845	7.5	Lebec
	11852.5	7.5	Frazier Mountain
	11900	7.5	Cuddy Valley
	11907.5	7.5	Sawmill Mountain
	11915	7.5	Apache Canyon
	11922.5	7.5	Cuyama Peak
	11930	7.5	Fox Mountain
	11937.5	7.5	Salisbury Potrero
	11945	15	McPherson Peak
	12000	15	Tepusquet Peak
	12015	15	Santa Maria
	12030	15	Point Sal
N3452.5	W11845	7.5	Pastoria Creek
	11852.5	7.5	Tecuya Creek
	11900	7.5	Pleito Hills
	11907.5	7.5	Eagle Rest Peak
	11915	7.5	Santiago Creek
	11922.5	7.5	Ballinger Canyon
	11930	7.5	East of Cuyama Ranch
	11937.5	7.5	Cuyama Ranch
N3500	W11400	60	Camp Mohave
	11430	30	Mohave City
	11500	60	Ivanpah
	11600	60	Avawatz Mountains
	11700	60	Searles Lake
	11745	15	Castle Butte

* These extend up to county line, 6 x 7.

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
	11800	30	Mojave
		15	Mojave
	11815	15	Tehachapi
	11830	30	Caliente
		15	Cummings Mountain
	11845	7.5	Tejon Hills
	11852.5	7.5	West of Tejon Hills
	11900	30	Buena Vista Lake
		7.5	Coal Oil Canyon
	11907.5	7.5	Hayes Ranch
	11915	7.5	Pentland
	11922.5	7.5	Maricopa
	11930	30	McKittrick
		7.5	Elkhorn Hills
	11937.5	7.5	Midway Peak S.W.
	11945	15	Caliente Mountain
	12000	15	Branch Mountain
	12015	15	Nipomo
	12030	30	San Luis
		15	Arroyo Grande
	12045	15	Port San Luis
N3507.5	W11837.5	7.5	Bear Mountain
	11845	7.5	Arvin
	11852.5	7.5	Weed Patch
	11900	7.5	Conner
	11907.5	7.5	Millux
	11915	7.5	Mouth of Kern
	11922.5	7.5	Buena Vista Hills
	11930	7.5	Fellows
	11937.5	7.5	Panorama Hills
N3515	W11730	15	Randsburg
	11745	15	Salt Dale
	11800	15	Cross Mountain
	11815	15	Emerald Mountain
	11830	15	Breckenridge Mountain
	11837.5	7.5	Bena
	11845	7.5	Edison
	11852.5	7.5	Fairfax School
	11900	15	Bakersfield West
		7.5	Gosford
	11907.5	7.5	Stevens
	11915	15	Buttonwillow
		7.5	Tupman
	11922.5	7.5	East Elk Hills
	11930	7.5	West Elk Hills
	11937.5	7.5	Olig
	11945	15	Simmler
	12000	15	La Panza
	12015	15	Pozo
	12030	15	San Luis Obispo
	12045	15	Cayucos
N3522.5	W11852.5	7.5	Oil Center
	11900	7.5	Oildale
	11907.5	7.5	Rosedale
	11915	7.5	Rio Bravo
	11922.5	7.5	Buttonwillow
	11930	7.5	Lokern
	11937.5	7.5	Belridge
N3530	W11745	15	Inyokern
	11800	30	Kernville
		15	Onyx
	11815	15	Isabella
	11830	30	Tobias Peak
		15	Glennville
	11845	15	Woody
	11900	15	Slater
		7.5	North of Oildale
	11907.5	7.5	Famosa
	11915	15	Wasco
		7.5	Wasco
	11922.5	7.5	Leonards
	11930	30	Lost Hills
		15	Hart Station
		7.5	Goose Lake
	11937.5	7.5	West of Goose Lake
	11945	7.5	Blackwell
	11952.5	7.5	Shale Point

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3537.5	12000	30	Cholame
		7.5	Packwood
	12007.5	7.5	Grant Lake
	12015	7.5	Commatti Canyon
	12022.5	7.5	Shedd Canyon
	12030	15	Paso Robles
	12045	15	Adelaida
	12100	15	San Simeon
	12115	15	Piedras Blancas
	W11900	7.5	Deepwell Ranch
	11907.5	7.5	McFarland
	11915	7.5	Pond
	11922.5	7.5	Hamlin School
	11930	7.5	Maramonte Ranch
	11937.5	7.5	Reynolds Ranch
	11945	7.5	Antelope Plain
	11952.5	7.5	Emigrant Hill
	12000	7.5	Sawtooth Ridge
	12007.5	7.5	Annette
	12015	7.5	Cholame
N3545	12022.5	7.5	Shandon
	W11845	15	White River
	11852.5	7.5	Quincy School
	11900	15	Terra Bella
		7.5	Richgrove
	11907.5	7.5	Delano
	11915	15	Earlimart
		7.5	Stone
	11922.5	7.5	Allensworth
	11930	15	Liberty Farms
		7.5	Hacienda Ranch
	11937.5	7.5	Lone Tree Well
	11945	15	La Rambla
		7.5	West Camp
	11952.5	7.5	Avenal Gap
	12000	7.5	Pyramid Hills
	12007.5	7.5	Tent Hills
	12015	7.5	Cholame Ranch
	12022.5	7.5	Cholame Hills
N3552.5	12030	15	San Miguel
	12045	15	Bradley
	12100	15	Bryson
	12115	15	Cape San Martin
	W11900	7.5	Ducor
	11907.5	7.5	Sausalito School
	11915	7.5	Pixley
	11922.5	7.5	Alpaugh
	11930	7.5	West Alpaugh
	11937.5	7.5	Harvester
	11945	7.5	Dudley Ridge
	11952.5	7.5	Los Viejos Hills
	12000	7.5	Kettleman Plain
	12007.5	7.5	Reef Ridge
	12015	7.5	The Dark Hole
	12022.5	7.5	Parkfield
N3600	W11500	60	Las Vegas
	11600	60	Furnace Creek
	11700	60	Ballarat
	11800	30	Olancho
	11830	30	Kaweah
	11900	15	Porterville
		7.5	Porterville
	11907.5	7.5	Woodville
	11915	15	Tulare
		7.5	Tipton
	11922.5	7.5	Lake View School
	11930	15	Corcoran
		7.5	Corcoran
	11937.5	7.5	El Rico Ranch
	11945	15	Stratford
		7.5	Chatom Ranch
	11952.5	7.5	Kettleman City
	12000	30	Coalinga
		15	Polvadero Gap
		7.5	La Cima
	12007.5	7.5	Canoas Creek
	12015	15	Coalinga
		7.5	Kreyenhagen Hills
	12030	30	Priest Valley
		15	Priest Valley

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3607.5	12045	15	San Ardo
	12100	15	King City
	12115	15	Junipero Serra
	12130	15	Lucia
	W11900	7.5	Lindsay
	11907.5	7.5	Cairns Corner
	11915	7.5	Tulare
	11922.5	7.5	Paige
	11930	7.5	Waukena
	11937.5	7.5	Guernsey
	11945	7.5	Stratford
	11952.5	7.5	Westhaven
	12000	7.5	Huron
	12007.5	7.5	Guijarral Hills
N3615	W11900	15	Exeter
		7.5	Rocky Hill
	11907.5	7.5	Exeter
	11915	7.5	Visalia
	11922.5	7.5	Goshen
	11930	7.5	Remnoy
	11937.5	7.5	Hanford
	11945	7.5	Lemoore
	11952.5	7.5	Lethent
	12000	7.5	West of Lethent
	12007.5	7.5	Delta Farms
	12015	15	Joaquin Rocks
	12030	15	New Idria
	12045	15	Hernandez Valley
N3622.5	12100	15	Metz
	12115	15	Soledad
	12130	15	Jamesburg
	12145	15	Point Sur
	W11900	7.5	Lemon Cove
	11907.5	7.5	Ivanhoe
	11915	7.5	Monson
	11922.5	7.5	Traver
	11930	7.5	Burris Park
	11937.5	7.5	Laton
	11945	7.5	Riverdale
	11952.5	7.5	Burrel
	12000	7.5	Wheatville
	12007.5	7.5	Towne Oil Station
N3630	12015	7.5	Mouth of Cantua Creek
	W11630	30	Bullfrog
	11800	30	Mount Whitney
	11830	30	Tehipite
	11900	30	Dinuba
		15	Dunlap
	11907.5	7.5	Stokes Mountain
	11915	7.5	Sultana
	11922.5	7.5	Reedley
	11930	7.5	Selma
	11937.5	7.5	Conejo
	11945	7.5	Caruthers
	11952.5	7.5	Raisin
	12000	15	Kerman
N3637.5		7.5	Helm
	12007.5	7.5	San Joaquin
	12015	7.5	Englebrecht Ranch
	12022.5	7.5	Levis
	12030	30	Panoche
		7.5	Monocline Ridge
	12037.5	7.5	Tumey Hills
	12045	15	Panoche Valley
	12100	15	San Benito
	12115	15	Gonzales
	12130	15	Salinas
	12145	15	Monterey
	W11915	7.5	Citrus Cove
	11922.5	7.5	Wahotoke
	11930	7.5	Sanger
	11937.5	7.5	Malaga
	11945	7.5	Fresno
	11952.5	7.5	Kearney Park
	12000	7.5	Kerman
	12007.5	7.5	Jamesan
	12015	7.5	Tranquillity
	12022.5	7.5	Tufts Ranch
	12030	7.5	Chaney Ranch
	12037.5	7.5	Tierra Loma School

<i>Index Number</i>		<i>Map Name</i>	
<i>Coordinates, S.E. corner of map</i>		<i>Minutes of latitude and longitude covered by map</i>	
<i>Latitude North</i>	<i>Longitude West</i>		
N3645	W11915	15	Watts Valley
	11922.5	7.5	Orangedale School
	11930	7.5	Round Mountain
	11937.5	7.5	Clovis
	11945	7.5	Bullard
	11952.5	7.5	Herndon
	12000	7.5	Biola
	12007.5	7.5	Gravelly Ford
	12015	7.5	Mendota
	12022.5	7.5	Firebaugh
	12030	7.5	Wisdom Well
	12037.5	7.5	Little Panoche
	12045	15	Ortiguila Peak
		7.5	Laguna Seca Ranch
	12100	15	Quien Sabe
	12115	15	Hollister
	12130	15	San Juan Bautista
	12145	15	Capitola
N3652.5	W11930	7.5	Academy
	11937.5	7.5	Friant
	11945	7.5	Lanes Bridge
	11952.5	7.5	Gregg
	12000	7.5	Madera
	12007.5	7.5	Bonita Ranch
	12015	7.5	Kentucky Well
	12022.5	7.5	Pozo Farm
	12030	7.5	Oxalis
	12037.5	7.5	Dos Palos
	12045	7.5	Charleston School
	12052.5	7.5	Ortiguila
N3700	W11700	60	Lida
	11800	30	Bishop
	11830	30	Mount Goddard
	11900	30	Kaiser
	11930	30	Mariposa
		15	Millerton Lake
	11937.5	7.5	Sulphur Springs
	11945	15	Raymond
		7.5	Little Table Mountain
	11952.5	7.5	Daulton
	12000	7.5	Kismet
	12007.5	7.5	Berenda
	12015	15	Athlone
		7.5	Chowchilla
	12022.5	7.5	Bliss Ranch
	12030	7.5	Santa Rita Bridge
	12037.5	7.5	Delta Ranch
	12045	7.5	Los Banos
	12052.5	7.5	Volta
N3707.5	12100	15	Pacheco Pass
		7.5	San Luis Creek
	12115	15	Gilroy Hot Springs
	12130	15	Morgan Hill
	12145	15	New Almaden
	12200	30	Santa Cruz
		15	Ben Lomond
	12215	15	Año Nuevo
	W12000	7.5	Raynor Creek
	12007.5	7.5	Le Grand
	12015	7.5	Plainsberg
	12022.5	7.5	Lingard
	12030	7.5	Sandy Mush
	12037.5	7.5	Turner Ranch
	12045	7.5	San Luis Ranch
N3715	12052.5	7.5	Ingomar
	12100	7.5	Howard Ranch
	W12000	15	Indian Gulch
	12007.5	7.5	Owens Creek
	12015	7.5	Planada
	12022.5	7.5	Merced
	12030	7.5	Atwater
	12037.5	7.5	Arena
	12045	7.5	Stevinson
	12052.5	7.5	Gustine
	12100	15	Orestimba
		7.5	Newman
	12107.5	7.5	Orestimba Creek
	12115	15	Mount Boardman

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3722.5	12130	15	Mount Hamilton
	12145	15	San Jose
	12200	15	Palo Alto
	12215	15	Half Moon Bay
	W12015	7.5	Haystack Mountain
	12022.5	7.5	Hopeton
	12030	7.5	Winton
	12037.5	7.5	Cressey
	12045	7.5	Turlock
	12052.5	7.5	Mitchell School
N3730	12100	7.5	Crows Landing
	12107.5	7.5	Patterson
	W11730	30	Silver Peak
	11800	30	White Mountain
	11830	30	Mount Morrison
	11900	30	Mount Lyell
	11930	30	Yosemite
	12000	30	Sonora
	12015	15	Merced Falls
	12022.5	7.5	Merced Falls
N3737.5	12030	7.5	Snelling
	12037.5	7.5	Three Tree Flat
	12045	15	Montpellier
	12052.5	7.5	Modesto East
	12100	15	Denair
	12107.5	7.5	Ceres
	12115	15	Modesto West
	12130	15	Westport
	12145	15	Westley
	12200	15	Carbona
N3745	12215	15	Romain
	W12022.5	7.5	Tesla
	12030	7.5	Pleasanton
	12037.5	7.5	Hayward(s)
	12045	7.5	San Mateo
	12052.5	7.5	La Grange
	12100	7.5	Cooperstown
	12107.5	7.5	Paulsell
	12115	7.5	Waterford
	12122.5	7.5	Riverbank
N3752.5	12130	7.5	Salida
	12137.5	7.5	Ripon
	12145	15	Vernalis
	12200	15	Tracy
	12215	15	Midway
	12230	15	Copperopolis
	12245	15	Farmington
	12260	15	Oakdale
	12275	15	Thalheim
	12290	15	Avena
N3800	12300	15	Manteca
	12315	15	Lathrop
	12330	15	Union Island
	12345	15	Byron
	12360	15	Bethany
	12375	15	Byron Hot Springs
	12390	15	Mount Diablo
	12405	15	Concord
	12420	15	San Francisco
	12435	15	Tamalaipas
N3800	W12045	7.5	Bachelor Valley
	12052.5	7.5	Trigo
	12100	7.5	Peters
	12107.5	7.5	Burnham
	12115	7.5	Stockton
	12122.5	7.5	Holt
	12130	7.5	Woodward Island
	12137.5	7.5	Brentwood
	12145	7.5	Lone Tree Valley
	W11800	60	Hawthorne
N3800	11900	30	Bridgeport
	11930	30	Dardanelles
	12000	30	Big Trees
	12030	30	Jackson
	12045	15	Valley Springs
	12100	30	Lodi
	12115	15	Bellota
	12130	7.5	Linda
	12145	15	San Jose
	12200	15	Palo Alto

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
	12107.5	7.5	Waterloo
	12115	15	Lodi
		7.5	Castle
	12122.5	7.5	Headreach
	12130	7.5	Bouldin
	12137.5	7.5	Jersey
	12145	15	Antioch
		7.5	Collinsville
	12152.5	7.5	Honker Bay
	12200	30	Napa
		15	Carquinez
	12215	15	Mare Island
	12230	15	Petaluma
	12245	15	Point Reyes
N3807.5	W12100	7.5	Clements
	12107.5	7.5	Lockeford
	12115	7.5	Woodbridge
	12122.5	7.5	New Hope
	12130	7.5	Isleton
	12137.5	7.5	Rio Vista
	12145	7.5	Birds Landing
	12152.5	7.5	Denverton
N3810	W12200	7.5	Suisun
N3815	W12045	15	Sutter Creek
	12100	7.5	Goose Creek
	12107.5	7.5	Clay
	12115	15	Franklin
		7.5	Galt
	12122.5	7.5	Bruceville
	12130	15	Courtland
		7.5	Vorden
	12137.5	7.5	Cache Slough
	12145	15	Vacaville
		7.5	Maine Prairie
	12152.5	7.5	Elmira
	12200	15	Mount Vaca
	12215	15	Sonoma
	12230	15	Santa Rosa
	12245	15	Sebastopol
	12300	15	Duncans Mills
N3822.5	W12100	7.5	Bodega Head
	12107.5	7.5	Carbondale
	12115	7.5	Cosumnes
	12122.5	7.5	Elk Grove
	12130	7.5	Florin
	12137.5	7.5	Babel Slough
	12145	7.5	Saxon
	12152.5	7.5	Dixon
	12300	7.5	Wolfskill
	12307.5	7.5	Duncans Mills
N3830	W11900	30	Arched Rock
	11930	30	Wellington
	12000	30	Markleeville
	12030	30	Pyramid Peak
	12100	30	Placerville
		15	Sacramento
	12107.5	7.5	Folsom
	12115	15	Buffalo Creek
		7.5	Fairoaks
	12122.5	7.5	Mills
	12130	15	Brighton
		7.5	Davisville
	12137.5	7.5	Lovdal
	12145	15	Swingle
		7.5	Woodland
	12152.5	7.5	Merritt
	12200	15	Winters
	12215	15	Capay
	12230	15	St. Helena
	12245	15	Calistoga
	12300	15	Healdsburg
		7.5	Skaggs
	12307.5	7.5	Cazadero
	12315	15	Fort Ross
		7.5	Plantation
			Plantation

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3837.5	W12107.5	7.5	Folsom
	12115	7.5	Antelope
	12122.5	7.5	Arcade
	12130	7.5	Elkhorn Weir
	12137.5	7.5	Grays Bend
	12145	7.5	Yolo
	12152.5	7.5	Jacobs Corner
	12200	7.5	Esparto
	12300	7.5	Skaggs Springs
	12307.5	7.5	Tombs Creek
	12315	7.5	Annapolis
	12322.5	7.5	Stewarts Point
	W12100	15	Auburn
	12115	15	Markham Ravine
N3845		7.5	Roseville
	12122.5	7.5	Pleasant Grove
	12130	7.5	Vernon
	12137.5	7.5	Knights Landing
	12145	15	Dunnigan
		7.5	Ronda
	12152.5	7.5	Zamora
	12200	15	Rumsey
	12215	15	Morgan Valley
	12230	15	Lower Lake
	12245	15	Kelseyville
	12300	15	Hopland
	12315	15	Ornbaun
	12330	15	Point Arena
N3852.5	W12115	7.5	Lincoln
	12122.5	7.5	Sheridan
	12130	7.5	Nicolaus
	12137.5	7.5	Marcuse
	12145	7.5	Kirkville
	12152.5	7.5	Hershey
	12200	7.5	Harrington
	W12000	30	Truckee
	12030	30	Colfax
	12100	30	Smartsville
N3900	12115	7.5	Spenceville
	12122.5	7.5	Wheatland
	12130	30	Marysville
		15	Marysville
		7.5	Ostrom
	12137.5	7.5	Gilsizer Slough
	12145	7.5	Tisdale Weir
	12152.5	7.5	Grimes
	12200	15	Colusa
		7.5	Arbuckle
	12207.5	7.5	Spring Valley
	12215	15	Wilbur Springs
	12230	15	Bartlett Springs
	12245	15	Lakeport
N3907.5	12300	15	Ukiah
	12315	15	Orrs
	12330	15	Saddle Point
	12345	15	Albion
	W12115	7.5	Parks Bar
	12122.5	7.5	Browns Valley
	12130	7.5	Yuba City
	12137.5	7.5	Sutter
	12145	7.5	Marysville Buttes
	12152.5	7.5	Meridian
N3915	12200	7.5	Powell Slough
	12207.5	7.5	Williams
	12215	7.5	Fairview
	W12115	15	Bangor
	12122.5	7.5	Prairie Creek
	12130	15	Gridley
		7.5	Honcut
	12137.5	7.5	Gridley
	12145	15	Butte Sink
		7.5	Pennington
	12152.5	7.5	Sanborn Slough
	12200	15	Maxwell
		7.5	Compton Landing

Index Number		Map Name	
Coordinates, S.E. corner of map		Minutes of latitude and longitude covered by map	
Latitude North	Longitude West		
N3922.5	12207.5	7.5	Delevan
	12215	15	Lodoga
		7.5	Sites
	12245	15	Hullville
	12300	15	Pomo
	12315	15	Willits
	12330	15	Glenblair
	12345	15	Fort Bragg
	W12130	7.5	Palermo
	12137.5	7.5	Biggs
	12145	7.5	Landlow
	12152.5	7.5	Butte City
N3930	12200	7.5	Princeton
	12207.5	7.5	Logandale
	12215	7.5	Logan Creek
	W12000	30	Sierraville
	12030	30	Downieville
	12100	30	Bidwell Bar
	12130	30	Chico
		15	Oroville
		7.5	Oroville
	12137.5	7.5	Dry Creek
	12145	7.5	Nelson
	12152.5	7.5	Newhard
N3937.5	12200	15	Willows
		7.5	Jacinto
	12207.5	7.5	Lyman
	12215	15	Fruto
		7.5	Kurand
	12230	15	Elk Creek
	12300	15	Eden Valley
	12315	15	Laytonville
	12330	15	Branscomb
	12345	15	Cape Vizcaino
	W12137.5	7.5	Clear Creek
	12145	7.5	Durham
N3945	12152.5	7.5	Chico Landing
	12200	7.5	Hamilton
	12207.5	7.5	Orland
	12215	7.5	Walker Creek
	W12030	15	Blairsden
	12145	15	Richardson Springs
		7.5	Keefers
	12152.5	7.5	Nord
	12200	15	Vina
		7.5	McIntosh Landing
	12207.5	7.5	Kirkwood
	12215	15	Flournoy
N3952.5	12230	15	Paskenta
	12245	15	Number D
	12300	15	Covelo
	12315	15	Covelo
	12330	15	Cummings
	12345	15	Kenny
	W12152.5	7.5	Singer Creek
	W12000	60	Honey Lake
	12100	60	Lassen Peak
	12130	30	Mineral
	12200	60	Red Bluff
		15	Tehama
N4015	12300	30	Hoaglin
		15	Number E
	12315	15	Island Mountain
	12330	15	Harris
	12345	15	Briceland
	12400	15	Point Delgada
	12415	15	Gorda
	W12315	15	Anada
	12330	15	South Fork Peak
	12345	15	Dyerville
	12400	15	Glynn
	12415	15	Cape Mendocino
N4030	W12100	30	Halls Flat
	12130	30	Burney
	12200	30	Redding
	12230	30	Weaverville
	12300	30	Big Bar and Vicinity

<i>Index Number</i>		<i>Map Name</i>	
<i>Coordinates, S.E. corner of map</i>		<i>Minutes of latitude and longitude covered by map</i>	
<i>Latitude North</i>	<i>Longitude West</i>		
	12330	15	Pilot Creek
	12345	15	Kneeland
	12400	15	Fortuna
	12415	15	Ferndale
N4045	W12330	15	China Flat
	12345	15	Blue Lake
	12400	15	Eureka
N4100	W12000	60	Alturas
	12100	60	Modoc Lava Bed
	12130	30	Bartle
	12200	60	Shasta
		30	Dunsmuir
	12230	30	Etna
	12300	30	Sawyers Bar
	12330	30	Hoopa
	12345	15	Coyote Peak
	12400	30	Trinidad
N4115	W12345	15	Trinidad
	12400	15	Tectah Creek
N4130	W12200	30	Orick
	12230	30	MacDoel
	12245	15	Yreka
	12300	30	Fort Jones
	12330	30	Sciad
	12345	15	Preston Peak
	12400	30	Ship Mountain
		15	Crescent City
N4145	W12345	15	Requa
	12400	15	Gasquet
		15	Point St. George

SPECIAL ARTICLES

FLOW-SHEET OF AMERICAN POTASH AND CHEMICAL CORPORATION AT SEARLES LAKE, CALIFORNIA

By WALTER W. BRADLEY *

In the short story herein the writer lays no claim to originality, but intends merely to give a brief historical background for the presentation of the accompanying chart which shows the flow-sheet of the outstanding chemical and industrial plant of the American Potash and Chemical Corporation. The chart was supplied through the courtesy of the company and is reproduced by their permission. It was published recently in a similar form in *Chemical and Metallurgical Engineering* ¹.

The accompanying photographs were taken by the writer on visits to Trona during recent years.

Searles Lake in northwestern San Bernardino County, California, was named for John W. Searles, who, with his brother Dennis, first located a group of placer claims on the playa on the northwestern shore of the lake and began the gathering of borax there in 1873.² This desert dry "lake" had first been known as Slate Range Lake and later as Borax Flat. In 1878, Searles and associates incorporated as the San Bernardino Borax Mining Company, built a larger and more permanent plant than their previous experimental unit, and piped water from a canyon in the nearby mountains. The San Bernardino Borax Mining Company was sold in 1895 to the Pacific Coast Borax Company, who closed the plant and ceased operations because of their lower-cost production of borax of more desirable quality from the colemanite deposits in Death Valley and one or two other localities.

Searles Lake was quiescent until 1905 or 1906, when it was investigated as a source of soda ash. In 1908, the California Trona Company was organized, took over the plant and former assets of the San Bernardino Borax Company, and prepared to take out soda ash. They became involved in financial difficulties before reaching actual production, and in 1909 went into a receivership. Then followed a period marked by claim jumping and court action.

"*** Title was finally cleared in 1916 through a judgment which recognized the California Trona Company's claims and invalidated those of the invading parties.

"In February of 1913 the Government withdrew the whole of Searles Lake as a potash reserve. At that time the California Trona Company held claims amounting to 26,000 acres, but as exploration work proceeded and the character of the lake was more clearly developed the less advantageous claims were dropped one by one until finally, in 1918, when the assessment work had been completed and the Government patented to them a clear title to their claims the amount they actually asked for and received was 3,320 acres to the north of the center of the lake. The rest of the body of the lake was promptly leased by the Government to eight or ten different interests for the production of potash, but none of these leaseholders has ever produced potash in commercial quantities.

* State Mineralogist.

¹ October 1945, pp. 134-137.

² Teeple, John E., The industrial development of Searles Lake brines, with equilibrium data: Am. Chem. Soc., Mon. 49, p. 20, 1929.

"It is not clear when the occurrence of potash in Searles Lake was first reported, but it is known that analyses made as far back as 1898 showed its presence * * *. By 1912 the presence here of potash was so well known that it came to the attention of the Government, and the Government Geological Survey sent representatives to investigate and published a bulletin on the subject * * *.

"By 1912 the California Trona Company had in hand as the result of all investigations a voluminous report on the utilization of the brine for the manufacture of potash, borax, soda ash, and sulphate of soda."³

Operational and financial difficulties ensued; the American Trona Corporation was organized to take over the assets of California Trona Company. A new plant was built in 1914, which was not successful. Various processes were considered and tried, resulting finally in a plant from which today's flow-sheet is the successful development. This plant began commercial operation in September 1916. By the middle of 1924 the plant was operating steadily, sales were going smoothly, income showed a regular margin above outgo. In the summer of 1926, the name was changed to the American Potash and Chemical Corporation. Since that time the plant has expanded in capacity, in refinements, and in number of products.

"Searles Lake is a 'dry' lake containing a large mass of crystals at its center. The exposed crystal body is surrounded by mud flats perhaps 100 square miles in area. It covers slightly less than 12 square miles and is a hard compact mass which will support automobiles, tractors, and other heavy rigs.

"It was estimated by the U. S. Geological Survey to contain 25 per cent of voids. These voids are permeated by a saturated brine which forms the raw material for the operations at Trona. The level of the brine stands close to the surface at all times and varies from about 6 inches above the level of the crystal to about 6 inches below. This variation is largely due to flooding in the winter months and evaporation of this flood water during the dry summers."⁴

Gale⁵ gives the following composition and analysis:

"The following six solid phases have been identified in the main crystal body of Searles Lake (water-soluble salts only): halite (NaCl); tincal (borax), $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$; trona, $\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$; glaserite, $\text{K}_2\text{Na}(\text{SO}_4)_2$; hanksite, $9\text{Na}_2\text{SO}_4 \cdot 2\text{Na}_2\text{CO}_3 \cdot \text{KCl}$; and sulphohalite, $2\text{Na}_2\text{SO}_4 \cdot \text{NaCl} \cdot \text{NaF}$. In addition to the above solid phases, other minerals, such as thenardite, burkeite as reported by Foshag,⁶ etc., are to be found in isolated strata in the surrounding mud where other sets of equilibrium conditions exist.

"Table I. Typical Analysis of Searles Lake Brine

Total	K	Calculated to KCl	4.70%
Remaining	Cl	Calculated to NaCl	16.35
Total	CO_2	Calculated to Na_2CO_3	4.70
Total	SO_3	Calculated to Na_2SO_4	6.96
Total	B_2O_3	Calculated to $\text{Na}_2\text{B}_4\text{O}_7$	1.50
Total	P_2O_5	Calculated to Na_3PO_4	0.16
Total	F	Calculated to NaF	0.01
Other minor constituents			0.30
Total salts (approx.)			34.68
Water			65.32
Specific gravity			1.30
pH			9.48

"In the industrial development of Searles Lake brine for the recovery of potash and other products, however, it has been found that other lesser constituents concentrate and finally enter into the equilibrium reactions. Therefore we have to take into consideration at least four more components—namely, AsO_4 , S, Br, and Li—making thirteen components in all."

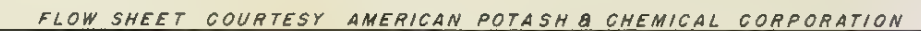
³ Teeple, op. cit. p. 22.

⁴ Mumford, R. W., Potassium chloride from the brine of Searles Lake: Ind. and Eng. Chem., vol. 30, p. 873, August 1938.

⁵ Gale, W. A., Chemistry of the trona process: Ind. and Eng. Chem., vol. 30, p. 869, August 1938.

⁶ Foshag, W. F., Am. Mineralogist, vol. 20, pp. 50-56, 1935.

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A. CORING A NEW WELL FOR POTASH-BORAX-SODA-BEARING BRINE,
AMERICAN POTASH AND CHEMICAL CORPORATION,
SEARLES LAKE, CALIFORNIA

Reprinted from Division of Mines Bulletin 121, California Mineral Production for 1940.



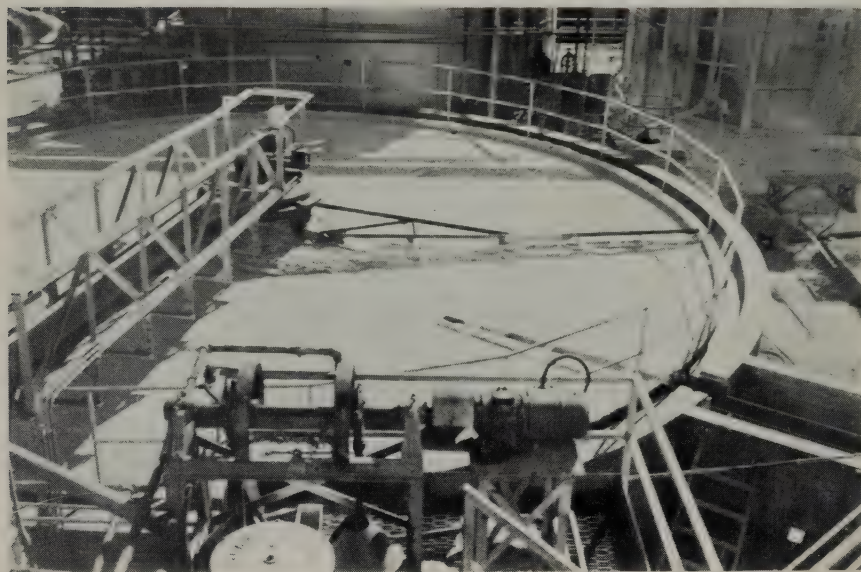
B. A UNIT OF THE PLANT AT TRONA

Reprinted from Division of Mines Bulletin 122, California Mineral Production for 1941.



A, SODA SECTION OF THE AMERICAN POTASH AND CHEMICAL CORPORATION PLANT AT TRONA

Reprinted from Division of Mines Bulletin 126, California Mineral Production for 1942.



B, SKIMMING OFF SODIUM-LITHIUM PHOSPHATE IN THE PLANT AT TRONA

Reprinted from Division of Mines Bulletin 126, California Mineral Production for 1938.

The process as now employed at Trona for the manufacture of potash, borax, sodium carbonate, sodium sulphate, potassium sulphate, and lithium salts is essentially one of evaporation followed by fractional crystallization. The recovery of lithium has been described by Gale,⁷ recounting "how a nuisance was turned into a profit at Trona."

In 1940, production was at the following rates:⁸

Muriate of potash	-----tons per day	525
Borax	-----tons per day	280
Soda ash	-----tons per day	145
Sodium sulphate products	-----tons per day	205
Crude lithium concentrates	-----tons per year	240
Employees (approximately)	-----	1000*

* In November 1945, from 1300 to 1400 men.

In 1938, on the occasion of the writer's first visit to Trona, the manager, Mr. A. A. Hoffman, as we were out on the lake looking at the seventeen wells then being pumped, said "We are 'mining' 15,000 tons of raw material per day with only two men!" Only two men were required to maintain operation of the electrically-driven, deep-well-type pumps. Mr. R. W. Mumford, the present manager, advises that they are now pumping from 20 to 25 wells, the increase being due to the expansion of the plant capacity; and that they were drawing too heavily on the older wells, also that the newer wells are better spaced. Booster pumps are installed in the pipe line leading (approximately four miles) to the storage tanks at the plant to provide necessary flexibility in the quantity of brine delivered.

"The brine is pumped at a temperature of 72°F. The pipeline is insulated against temperature changes by means of paper felt."⁹

"Raw brine is used as a condenser medium for the potash vacuum coolers. It is also used for washing various filter cakes throughout the plant before it enters the evaporators.

"The evaporator feed consists of a mixture of end liquors from the crystallizing house and brine from the lake. The end liquors can be considered as a carrier which takes up the potash and borax resulting from the evaporation of all the water from the raw brine entering the system. The resulting concentrated solution is then sent to the crystallizing plants for removal of the potash and borax, and the end liquor repeats the cycle."

Present plans call for expansion of the research and development department.

In addition to the literature cited above, papers on the geology, mineralogy, or the chemistry of the Searles Lake enterprise have been published by: Gale,¹⁰ Manning,¹¹ Robertson,¹² Ropp,¹³ Teeple,¹⁴ Turrentine,¹⁵ Foshag,¹⁶ Wells,¹⁷ Tucker and Sampson.¹⁸

⁷ Gale, W. A., *Lithium from Searles Lake: Chem. Ind.*, Sept. 1945, p. 442.

⁸ *The American Potash and Chemical Corporation*: p. 12. A brochure published by the company.

⁹ Mumford, R. W., *op. cit.*, p. 875.

¹⁰ Gale, H. S., *U. S. Geol. Surv.: Bull.* 580-L, 1912.

¹¹ Manning, P. T. V., *Chem. & Met. Eng.*, vol. 36, pp. 268-272, 1929.

¹² Robertson, G. R., *Ind. Eng. Chem.*, vol. 21, pp. 520-524, 1929.

¹³ Ropp, Alfred D., Jr., *Chem. & Met. Eng.*, vol. 19, p. 425, 1918; also *J. Ind. Eng. Chem.*, vol. 10, pp. 839-844, 1918.

¹⁴ Teeple, J. E., *J. Ind. Eng. Chem.*, vol. 13, p. 249, 1921; vol. 14, pp. 787, 904, 1922; vol. 19, p. 318, 1927.

¹⁵ Turrentine, J. W., *Potash*: pp. 74-82, 1926.

¹⁶ Foshag, W. F., *Amer. Mineral.*, vol. 20, pp. 50-56, 1935; vol. 25, pp. 769-778, 1940.

¹⁷ Wells, Roger, *Ind. Eng. Chem.*, vol. 13, p. 691, 1921.

¹⁸ Tucker, W. B., and Sampson, R. J., *Mineral resources of San Bernardino County, California: State Mineralogist's Reports*, XVII, pp. 357-358, 392-394; XXXIX, pp. 536, 537, 540.

MINERAL EXHIBIT AND STATISTICS

ACCESSIONS TO THE EXHIBIT

By HENRY H. SYMONS *

The museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of economic and academic value. It ranks among the first five such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

The exhibit is daily visited by service men, engineers, students, business men, and prospectors as well as tourists and sightseers. In addition to its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the Division of Mines, as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the exhibit are the following:

- 21202 HEULANDITE, $H_2CaAl_2(SiO_3)_4 \cdot 3H_2O$, one of the zeolite group of minerals, from Vandermade quarry at Prospect Park, N. J. Donor: T. Orchard Lisle. August 1945. Case 134.
- 21203 STILBITE, $H_4(Ca, Na_2)Al_2(SiO_3)_4 \cdot 4H_2O$, platy crystals, from Vandermade quarry at Prospect Park, N. J. Donor: T. Orchard Lisle, August 1945. Case 134.
- 21204 PEACOCK COAL from Silica Rock quarry near Ligonier, Pa. Donor: T. Orchard Lisle. August 1945. Case 151.
- 21205 HALITE— $NaCl$ from Great Salt Lake, Utah. Donor: Frank E. Call. September 1945. Case 112.
- 21206 Selenite GYPSUM from mud flats near Great Salt Lake, Utah. Donor: Frank E. Call. September 1945. Case 148.
- 21207 IRON concretions from Escalante, Utah. Donor: Frank E. Call. September 1945. Case 504.
- 21208 THINOLITES—a crystalline calcareous tufa from Humboldt Sink, Nevada. Donor: Frank E. Call. September 1945. Case 504.
- 21209 SCHEELITE— $CaWO_4$, from NW $\frac{1}{4}$ sec. 19, T. 17 S., R. 8 E., S. B., San Diego County. Donor: G. Sielaff. October 1945. Case 313.
- 21210 COPPER deposited on hammer in workings of the North Keystone mine, Copperopolis, Calaveras County, during period 1930 to 1942, inclusive, when property was idle. Donor: H. E. Bush, courtesy of Spangler Ricker. October 1945. Case 612.

* Statistician and Curator, California State Division of Mines.

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LIBRARY REPORT

By JAMES M. LITTLE *

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INTRODUCTION

The library of the Division of Mines contains more than 6,000 selected volumes on mines, mining, and allied subjects. It is also the repository for reports and bulletins of technical departments of Federal and State governments and educational institutions both domestic and foreign. Current copies of newspapers published in the mining centers of the State are also available for reference.

The library and reading room are open to the public during the usual hours, when the librarian may be freely called upon for all necessary assistance.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY AND UNITED STATES BUREAU OF MINES

The library of the Division of Mines has available for public reference the following publications of the United States Geological Survey: Annual Reports, Monographs, Professional Papers, Bulletins, Water-Supply Papers, Mineral Resources, Folios of the Geologic Atlas of the United States (broken file), Maps with Descriptive Text (broken file), Administrative Publications (broken file); and the following publications of the United States Bureau of Mines: Bulletins, Technical Papers, Economic Papers (broken file), Mineral Resources of the United States, Monographs (broken file), Reports of Investigations, Information Circulars.

Reports and maps, mainly on California, recently received from the Survey and Bureau of Mines include:

United States Geological Survey

Topographic Maps

- Artesia quadrangle, Los Angeles County, 1945, scale 1/24000.
- Bartlett Springs quadrangle, Lake and Colusa Counties, 1944, scale 1/62500.
- Cazadero quadrangle, Sonoma County, 1945, scale 1/31680.
- Duncan Mills quadrangle, Sonoma County, 1945, scale 1/31680.
- Dunlap quadrangle, Fresno and Tulare Counties, 1944, scale 1/62500.
- Lower Lake quadrangle, Lake and Sonoma Counties, 1945, scale 1/62500.
- Morgan Valley quadrangle, Lake, Colusa, Yolo and Napa Counties, 1944, scale 1/62500.

* Librarian, Division of Mines.

Skaggs Springs quadrangle, Sonoma County, 1944, scale 1/31680.
 St. Helena quadrangle, Lake and Napa Counties, 1945, scale 1/62500.
 Tombs Creek quadrangle, Sonoma County, 1945, scale 1/31680.

United States Bureau of Mines

Bulletin

460 Diatomites of the Pacific Northwest as Filter-Aids.

Information Circulars

7299 Bureau of Mines Exploration of Mercury.
 Deposits to June 30, 1944.
 7315 A Pattern for Western Steel Production.

War Minerals Reports

411 Whedon Manganese Mines, Paymaster District, Imperial County, California.
 418 Iron Mountain Deposits, San Bernardino County, Calif. (iron)
 422 Beneficiation of Carbonate and Oxide Manganese Ores from the Vicinity of Tracy, Central California.

PUBLICATIONS OF STATE SURVEYS

A broken file of mining and geological publications, issued by the organizations listed below, may be consulted in the library of the Division of Mines.

Alabama Geological Survey, University.
 Alaska (Territorial Commissioner of Mines), Juneau.
 Arizona Bureau of Mines, Tuscon.
 Arkansas Geological Survey, Little Rock.
 Colorado Bureau of Mines, Denver.
 Connecticut Geological and Natural History Survey, Hartford.
 Florida Department of Conservation, Tallahassee.
 Georgia Division of Geology, Atlanta.
 Idaho Bureau of Mines and Geology, Moscow.
 Illinois Geological Survey, Urbana.
 Indiana Division of Geology, Indianapolis.
 Iowa Geological Survey, Des Moines.
 State Geological Survey of Kansas, Lawrence.
 Kentucky Geological Survey, Frankfort.
 Louisiana Department of Conservation, New Orleans.
 Maine State Geologist, Augusta.
 Maryland Geological Survey, Baltimore.
 Michigan Geological Survey, Lansing.
 Minnesota Geological Survey, Minneapolis.
 Mississippi State Geological Survey, University.
 Missouri Bureau of Geology and Mines, Rolla.
 Montana Bureau of Mines and Geology, Butte.
 Nebraska Geological Survey, Lincoln.
 Nevada State Bureau of Mines, Reno.
 New Jersey Department of Conservation and Development, Trenton.
 New Mexico Bureau of Mines and Mineral Resources, Socorro.
 New York Science Division, Albany.
 North Carolina Geological and Economic Survey, Chapel Hill.
 North Dakota Geological Survey, Grand Forks.
 Ohio Geological Survey, Columbus.
 Oklahoma Geological Survey, Norman.
 Oregon State Department of Geology and Mineral Industries, Portland.
 Pennsylvania Topographic and Geological Survey, Harrisburg.
 South Dakota State Geological Survey, Vermillion.
 Tennessee Division of Geology, Nashville.
 Texas Bureau of Economic Geology, Austin.
 Virginia Geological Survey, University.
 Washington State Department of Conservation and Development, Pullman.
 West Virginia Geological Survey, Morgantown.
 Wisconsin Geological and Natural History Survey, Madison.
 Wyoming Geological Survey, Cheyenne.

PUBLICATIONS OF FOREIGN GOVERNMENTS

Publications of the following foreign governments are received and current issues may be consulted in the library. Earlier issues of foreign-language publications have been loaned to the California Academy of

Sciences in Golden Gate Park, because of the limited storage space at the Division's offices in the Ferry Building. They may, however, be consulted at the Academy.

Alberta Research Council, Edmonton.
 Argentina Direccion General de Minas y Geologica, Buenos Aires.
 British Columbia Minister of Mines, Victoria.
 British Museum of Natural History, London.
 Canada Department of Mines, Ottawa.
 Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
 Geological Service of Minas Geraes, Bella Horizonte, Brazil.
 Geological Survey of Scotland.
 Instituto Historica e Geographico, Rio de Janeiro.
 Museo de Historia Natural de Montevideo, Uruguay.
 New South Wales Department of Mines, Sydney, Australia.
 New Zealand Geological Survey Branch, Wellington.
 Nova Scotia Department of Public Works and Mines, Halifax.
 Ontario Department of Mines, Toronto, Canada.
 Quebec Bureau of Mines, Quebec.
 Queensland Department of Mines, Brisbane, Australia.
 South Australia Department of Mines, Adelaide.
 Transvaal Chamber of Mines, Johannesburg, South Africa.
 Western Australia Geological Survey, Perth.

PUBLICATIONS OF FOREIGN AND DOMESTIC SOCIETIES AND EDUCATIONAL INSTITUTIONS

Academia de Ciencias y Artes de Barcelona, Spain.
 Academy of Natural Sciences of Philadelphia.
 American Association of Petroleum Geologists, Tulsa, Oklahoma.
 American Geographical Society of New York.
 American Institute of Mining and Metallurgical Engineers, New York.
 American Journal of Science, New Haven, Conn.
 American Philosophical Society, Philadelphia.
 Australian Museum, Sydney.
 California Academy of Sciences, San Francisco.
 Canadian Institute of Mining and Metallurgy, Montreal.
 Carnegie Institution of Washington.
 Cleveland Museum of Natural History, Cleveland, Ohio.
 Colorado College Publications, Colorado Springs.
 Colorado Scientific Society, Denver.
 Commonwealth Club, San Francisco.
 Economic Geology, Lancaster, Pa.
 Field Museum of Natural History, Chicago.
 Franklin Institute of the State of Pennsylvania, Lancaster.
 Geological Society of America, Columbia University, New York.
 Geographical Society of London.
 Institution of Mining and Metallurgy, London.
 Instituto Geologico de Mexico, Mexico, D. F.
 Journal of Geology, Chicago.
 Mineralogical Society of America, Menasha, Wisconsin.
 Michigan College of Mining and Technology, Houghton.
 Mining and Metallurgical Society of America, New York.
 Missouri School of Mines and Metallurgy, Rolla.
 Museu Nacional, Rio de Janeiro.
 National Research Council, Washington, D. C.
 New York Academy of Sciences, New York.
 New York State Museum, Albany.
 Pennsylvania State College, State College.
 Philippine Journal of Science, Manila.
 Royal Society of South Australia, Adelaide.
 Seismological Society of America, Stanford University.
 Sierra club, San Francisco.
 Society of Economic Paleontologists and Mineralogists, Tulsa, Oklahoma.
 Southern California Academy of Sciences, Los Angeles.
 Stanford University, Palo Alto, California.
 University of California Publications in Engineering, Geography, and Geology, Berkeley.
 University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

CURRENT MAGAZINES

Current issues of the technical magazines listed below are on file in the reading room of the library, and may be consulted.

Published in
CALIFORNIA

Auburn

California Mining Journal—monthly.

Bakersfield

Mineral Notes News (Cal. Fed. of Min. Societies)—monthly.

Los Angeles

California Oil World—twice monthly.

California Safety News—monthly.

Grizzly Bear (Native Sons and Native Daughters of the Golden West)—monthly.

Petroleum World—monthly.

Southwest Builder and Contractor—monthly.

Sacramento

California Highways and Public Works.

San Francisco

California Fish and Game (State Division of Fish and Game)—quarterly.

California Magazine of the Pacific (State Chamber of Commerce)—monthly.

Mining and Industrial News—monthly.

Pacific Road Builder and Engineering Review—monthly.

Pacific Purchaser—monthly.

Standard Oil Bulletin—quarterly.

Whittier

Fusion Facts (Stoody Company)—quarterly.

ARIZONA

Phoenix

The Mining Journal—twice monthly.

Pay Dirt—monthly.

COLORADO

Golden

The Mines Magazine (Colorado School of Mines)—monthly.

DELAWARE

Wilmington

Hercules Mixer—monthly.

ILLINOIS

Chicago

Brick and Clay Record—monthly.

Light Metal Age—monthly.

Rock Products—monthly.

NEW YORK

New York

Chemical and Metallurgical Engineering—monthly.

Civil Engineering—monthly.

Engineering and Mining Journal—monthly.

Lubrication (The Texas Company)—monthly.

Mining and Metallurgy (A. I. M. & M. E.)—monthly.

Nickel Steel Topics—monthly.

Oil, Paint and Drug Reporter—weekly.

Scientific American—monthly.

OKLAHOMA

Tulsa

Independent Monthly (Petroleum Association of America).

Oil and Gas Journal—weekly.

PENNSYLVANIA

Philadelphia

Asbestos—monthly.

Chemical Industries—monthly.

TEXAS

Houston
Oil Weekly.

UTAH

Salt Lake City
Mining and Contracting Review—twice monthly.

WASHINGTON

Seattle
Mining World—monthly.

WASHINGTON, D. C.

Mining Congress Journal—monthly.

WISCONSIN

Milwaukee
The Driller—monthly.

Foreign**CANADA**

Gardenvale
Canadian Mining Journal—monthly.

AUSTRALIA

Melbourne
Chemical Engineering and Mining Review—monthly.

ENGLAND

London
The Gemmologist—monthly.

NEWSPAPERS

Current issues of the following papers are received and kept on file in the library:

*Published in***CALIFORNIA**

Angels Camp: Calaveras, California.
Auburn: Placer Herald.
Barstow: Barstow Printers Review.
Bishop: Inyo Register.
Colfax: Colfax Record.
Crescent City: Del Norte Triplicate.
Downieville: Mountain Messenger.
Grass Valley: The Union.
Independence: Inyo Independent.
Jackson: Amador Dispatch.
Los Angeles: Los Angeles Times—Monday only.
Mariposa: Mariposa Gazette.
Needles: Needles Nugget.
Nevada City: Nevada City Nugget.
Palo Alto: Palo Alto Citizen.
Placerville: Placerville Times.
Quincy: Feather River Bulletin and Plumas Independent.
Randsburg: Randsburg Times.
San Andreas: Calaveras Prospect.
San Francisco: Daily Commercial News and S. F. Municipal Review.
Sonora: The Banner.
 Tuolumne Independent.
 Union Democrat.
Tuolumne: Tuolumne Prospector.

Terra Bella: Terra Bella News.
Weaverville: Weekly Trinity Journal.
Yreka: Yreka Journal.

ARIZONA

Kingman: Mojave Miner.

COLORADO

Denver: Denver Mining Record.

GEORGIA

Atlanta: Outdoor Georgia.

NEVADA

Las Vegas: Las Vegas Age.
Reno: Mining Press.

WASHINGTON

Seattle: Alaska Weekly.

NEW BOOKS

Recent accessions to the library are the following books:

Barnes, R. B., Gore, R. C., Liddel, U. and Williams, V., *Infrared Spectroscopy*, 236 pp., New York, Reinhold Publishing Co., 1944.

Burton, E. F., and Kohl, W. H., *The Electron Microscope*, 233 pp., New York, Reinhold Publishing Co., 1942.

Cotton, C. A., *Landscape*, 301 pp., Cambridge, University Press, 1941.

Dingman, C. F., *Estimating Building Costs*, 401 pp., New York, McGraw-Hill Book Co., 1944 (F. W. Bradley Memorial Book Fund).

Duff, A. W., *Physics*, 8th Ed., 715 pp., Philadelphia, The Blakiston Co., 1943.

Engle, N. H., *Aluminum*, 494 pp., Chicago, Richard D. Irwin, Inc., 1945.

Everhart, J. L. and others, *Mechanical Properties of Metals and Alloys*, Circular of the National Bureau of Standards, 481 pp., Washington, U. S. Government Printing Office, 1943.

Fairlie, A. M., *Sulfuric Acid Manufacture*, 669 pp., New York, Reinhold Publishing Co., 1936.

Haynes, W., *The Stone that Burns*, 345 pp., New York, D. Van Nostrand Co., 1942. (F. W. Bradley Memorial Book Fund).

Hurlbut, C. H., *Dana's Manual of Mineralogy*, 15th Ed., 480 pp., New York, John Wiley & Sons, Inc., 1944.

Kemmerer, E. W., *Gold and the Gold Standard*, 238 pp., New York, McGraw-Hill Book Co., 1944. (F. W. Bradley Memorial Book Fund).

Leith, C. K., *World Minerals and World Peace*, 253 pp., Washington, The Brookings Institution, 1943.

McCurdy, P. G., *Manual of Photogrammetry*, 819 pp., New York Pitman Publishing Co., 1944. (F. W. Bradley Memorial Book Fund).

McIver, M. E., *Technologists' Stake in the Wagner Act*, 260 pp., Chicago American Association of Engineers, 1944. (F. W. Bradley Memorial Book Fund).

McKay, R. J. and Worthington, R., *Corrosion Resistance of Metals and Alloys*, 492 pp., New York, Reinhold Publishing Co., 1936. (F. W. Bradley Memorial Book Fund).

Taggart, F. T., *Handbook of Mineral Dressing, Ores and Industrial Minerals*, 1915, pp., New York, John Wiley & Sons, Inc., 1944.

Winchell, A. N., *Elements of Mineralogy*, 535 pp., New York, Prentice-Hall, Inc., 1942.

SERVICES OF THE DIVISION OF MINES

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January 1922, and continued until March 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September 1923. For the same reason, beginning with the January 1924 issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January 1933 chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

TYPES OF REPORTS

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g., feldspar).
3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

Reports of District Mining Engineers

In 1919-1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the frontispiece outline map of the State.

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

Special Articles

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

MAIL AND FILES

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

The library has a card-file system for references to individual California mines, occurring in the publications of the Division of Mines, in the Mining and Scientific Press, the Engineering and Mining Journal, and the Arizona Mining Journal.

COMMERCIAL MINERAL NOTES

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past

has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of *Commercial Mineral Notes*, and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

DETERMINATION OF MINERAL SAMPLES

Samples (limited to two in one month) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-five years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco 11; State Building, Los Angeles 12; State Office Building No. 1, Sacramento 14; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

Write for latest revised price list.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Report I of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	-----
**Report II of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	-----
**Report III of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	-----
**Report IV of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	-----
**Report V of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geo- logical map. Henry G. Hanks	-----
**Report VI of the State Mineralogist, Part 1, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	-----
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	-----
Price \$0.75, sales tax \$0.02	\$0.77
**Report VII of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	-----
**Report VIII of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	-----
Report IX of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	-----
Price \$1.15, sales tax \$0.03	1.18
**Report X of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	-----
Report XI (First Biennial) of the State Mineralogist, for the two years end- ing September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	-----
Price \$1.50, sales tax \$0.04	1.54
**Report XII (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	-----
**Report XIII (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	-----
Chapters of the State Mineralogist's Report XIV, Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Coun- ties, 172 pp., paper	-----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	-----
Price \$0.50, sales tax \$0.01	.51
Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Coun- ties, 59 pp., paper	-----
Price \$0.35, sales tax \$0.01	.36
Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	-----
Price \$0.75, sales tax \$0.02	.77
Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	-----
Price \$0.50, sales tax \$0.01	.51
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	-----
**Report XIV of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	-----
Chapters of the State Mineralogist's Report XV, Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	-----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	-----
Price \$0.50, sales tax \$0.01	.51
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	-----

REPORTS—Continued

	Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.	
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper -----	----
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper -----	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper -----	----
**Report XV of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth-----	----
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
**Mines and Mineral Resources of Nevada County, 270 pp., paper -----	----
Mines and Mineral Resources of Plumas County, 188 pp., paper -----	----
Price \$0.50, sales tax \$0.01	\$0.51
Mines and Mineral Resources of Sierra County, 144 pp., paper -----	----
Price \$0.75, sales tax \$0.02	.77
Report XVII of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth -----	----
Price \$2.50, sales tax \$0.06	2.56
Report XVIII of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922: **January, **February, **March, April, May, June, July, August, September, October, November, December, 1922 -----	----
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XIX of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 -----	----
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XX of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, ** July, October, 1924, per copy -----	----
Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXI of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly: January, 1925. Mines and Mineral Resources of Sacramento, Monterey and Orange Counties -----	----
Price \$0.30, sales tax \$0.01	.31
**April, 1925. Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties -----	----
**July, 1925. Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties -----	----
**October, 1925. Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties -----	----
Chapters of Report XXII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly: **January, 1926. Mines and Mineral Resources of Trinity and Santa Cruz Counties -----	----
**April, 1926. Mines and Mineral Resources of Shasta, San Benito and Imperial Counties -----	----
July, 1926. Mines and Mineral Resources of Marin and Sonoma Counties -----	----
Price \$0.30, sales tax \$0.01	.31
**October, 1926. Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County -----	----
Chapters of Report XXIII of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly: January, 1927. Mines and Mineral Resources of Contra Costa County; Santa Catalina Island -----	----
Price \$0.30, sales tax \$0.01	.31

REPORTS—Continued

		Price (including postage and sales tax)
Asterisks (**) indicate the publication is out of print.		
April, 1927. Mines and Mineral Resources of Amador and Solano Counties	Price \$0.30, sales tax \$0.01	\$0.31
**July, 1927. Mines and Mineral Resources of Placer and Los Angeles Counties	-----	---
October, 1927. Mines and Mineral Resources of Mono County	Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXIV of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1928. Mines and Mineral Resources of Tuolumne County	Price \$0.30, sales tax \$0.01	.31
April, 1928. Mines and Mineral Resources of Mariposa County	Price \$0.30, sales tax \$0.01	.31
**July, 1928. Mines and Mineral Resources of Butte and Tehama Counties	-----	---
October, 1928. Mines and Mineral Resources of Plumas and Madera Counties	Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXV of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
**January, 1929. Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	-----	---
**April, 1929. Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	-----	---
July, 1929. Mines and Mineral Resources of Colusa, Fresno and Lake Counties	Price \$0.30, sales tax \$0.01	.31
October, 1929. Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	Price \$0.30, sales tax \$0.01	.31
Chapters of Report XXVI of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1930. Mines and Mineral Resources of Santa Clara County; also Barite in California	Price \$0.40, sales tax \$0.01	.41
**April, 1930. Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	-----	---
**July, 1930. Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	-----	---
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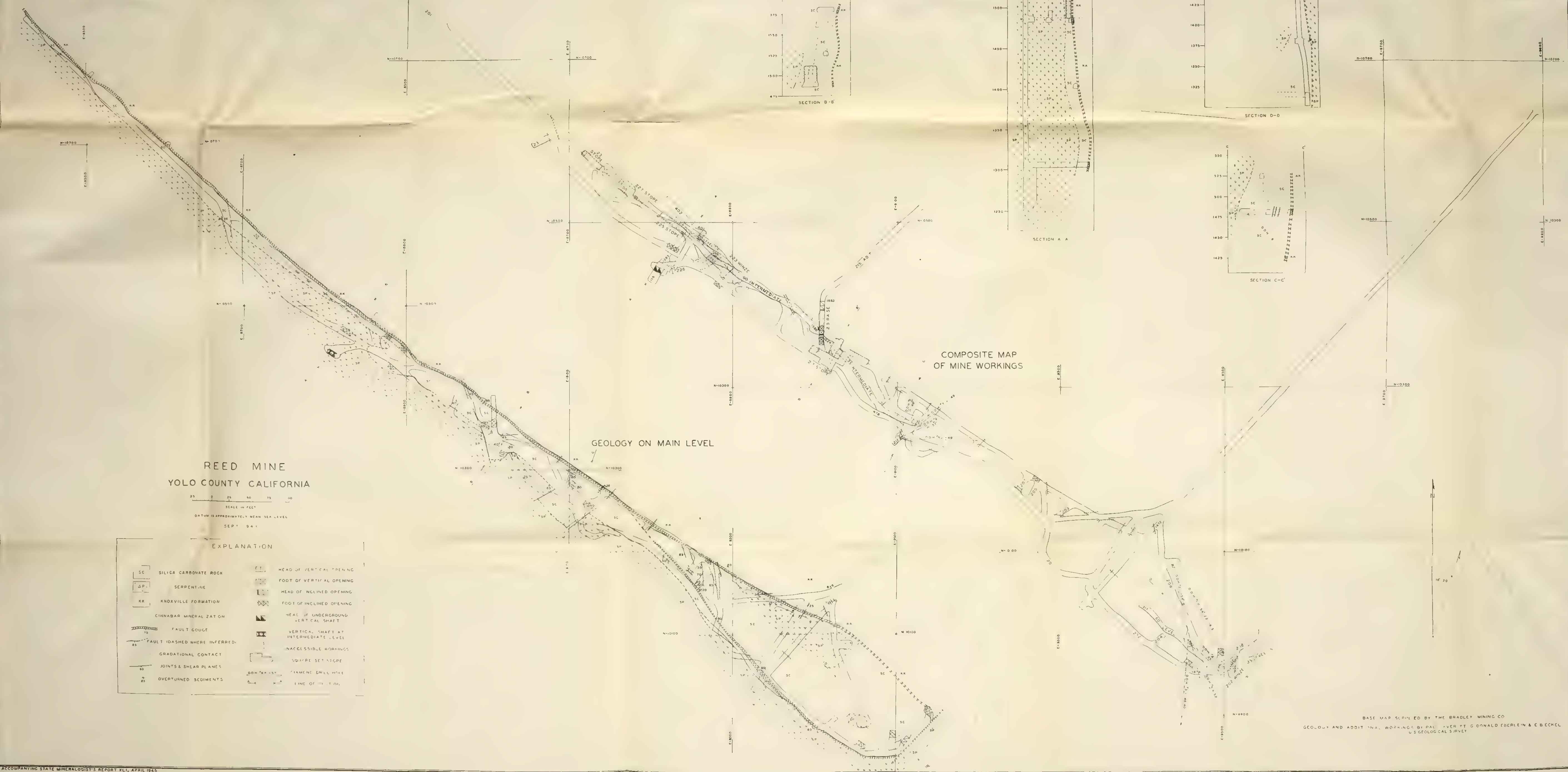
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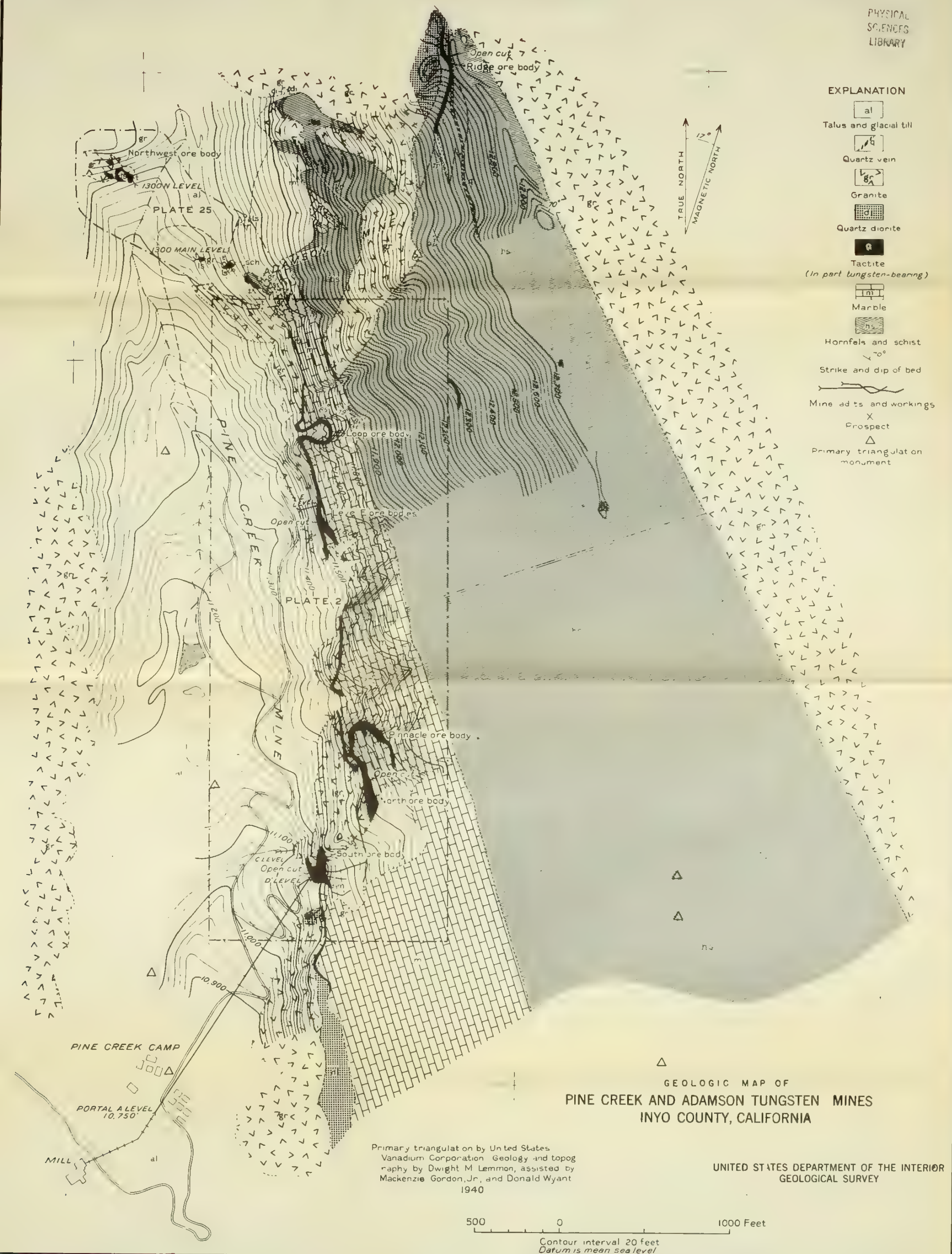
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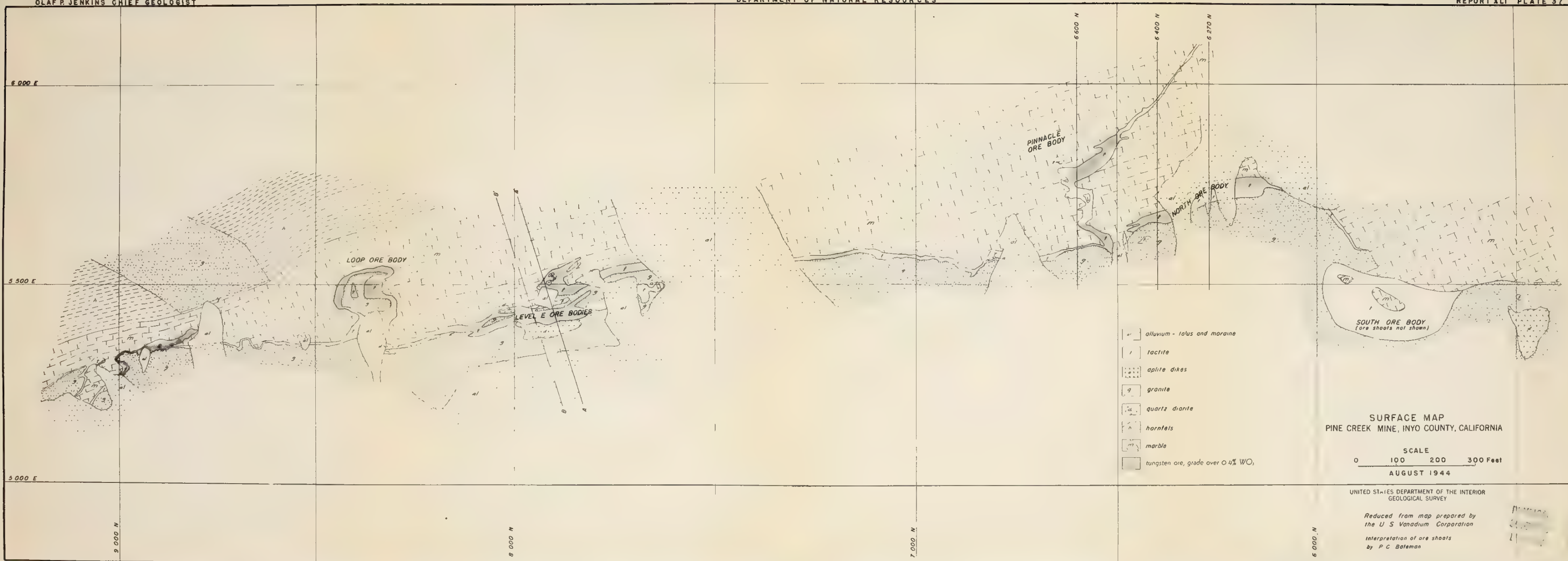


BASE MAP SUPPLIED BY THE BRADLEY MINING CO.
GEOLOGY AND ADDITIONAL WORKINGS BY RALPH W. BRADLEY, OLAF P. JENNINS, & C. BECKEL
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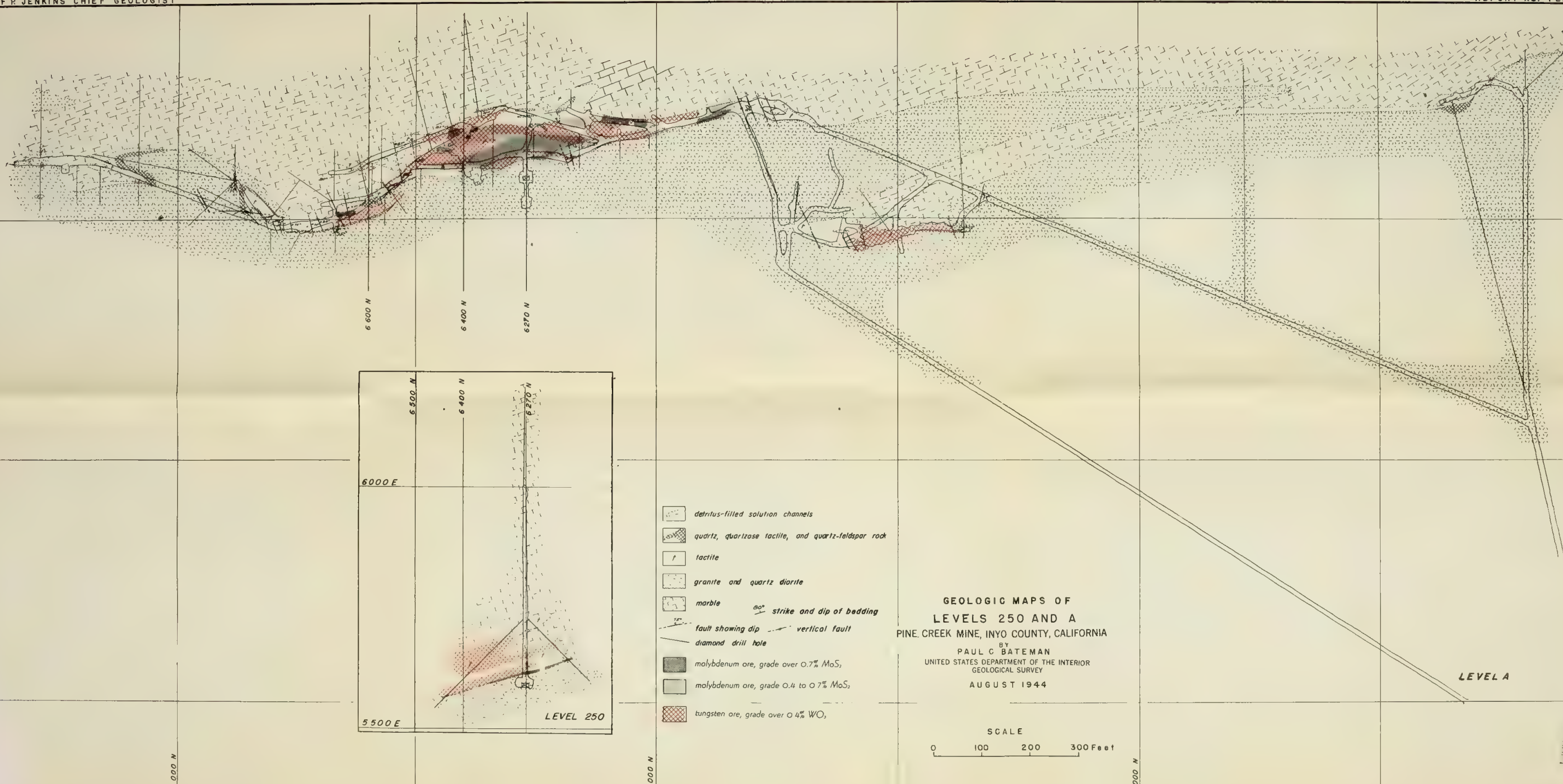
EXPLANATION

Primary triangulation monument







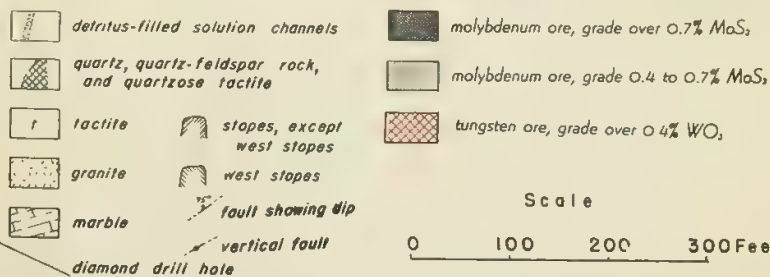
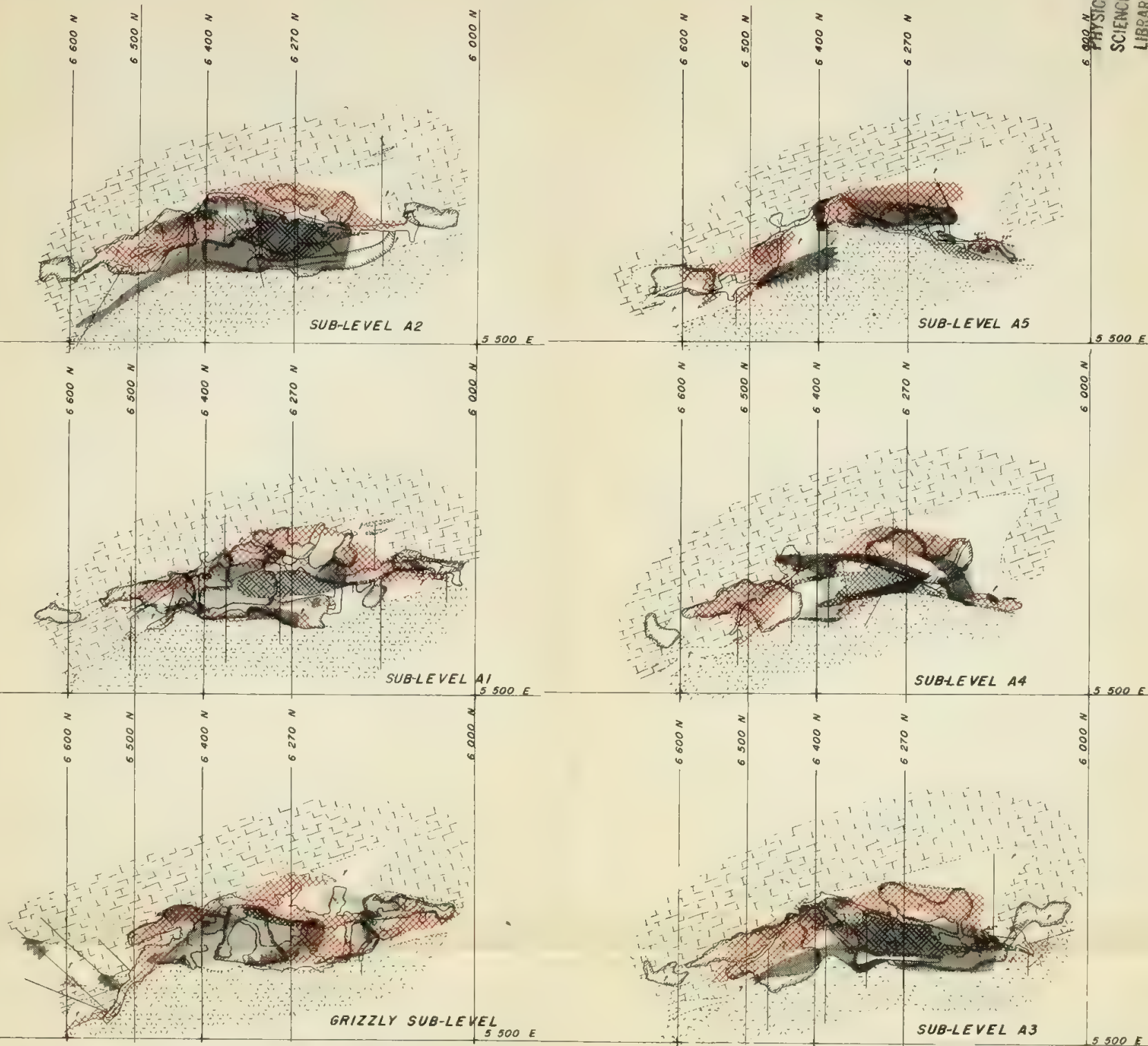


- detritus-filled solution channels
- quartz, quartzose tectite, and quartz-feldspar rock
- tectite
- granite and quartz diorite
- marble
- strike and dip of bedding
- fault showing dip
- vertical fault
- diamond drill hole
- molybdenum ore, grade over 0.7% MoS₂
- molybdenum ore, grade 0.4 to 0.7% MoS₂
- tungsten ore, grade over 0.4% WO₃

GEOLOGIC MAPS OF
LEVELS 250 AND A
PINE CREEK MINE, INYO COUNTY, CALIFORNIA
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AUGUST 1944

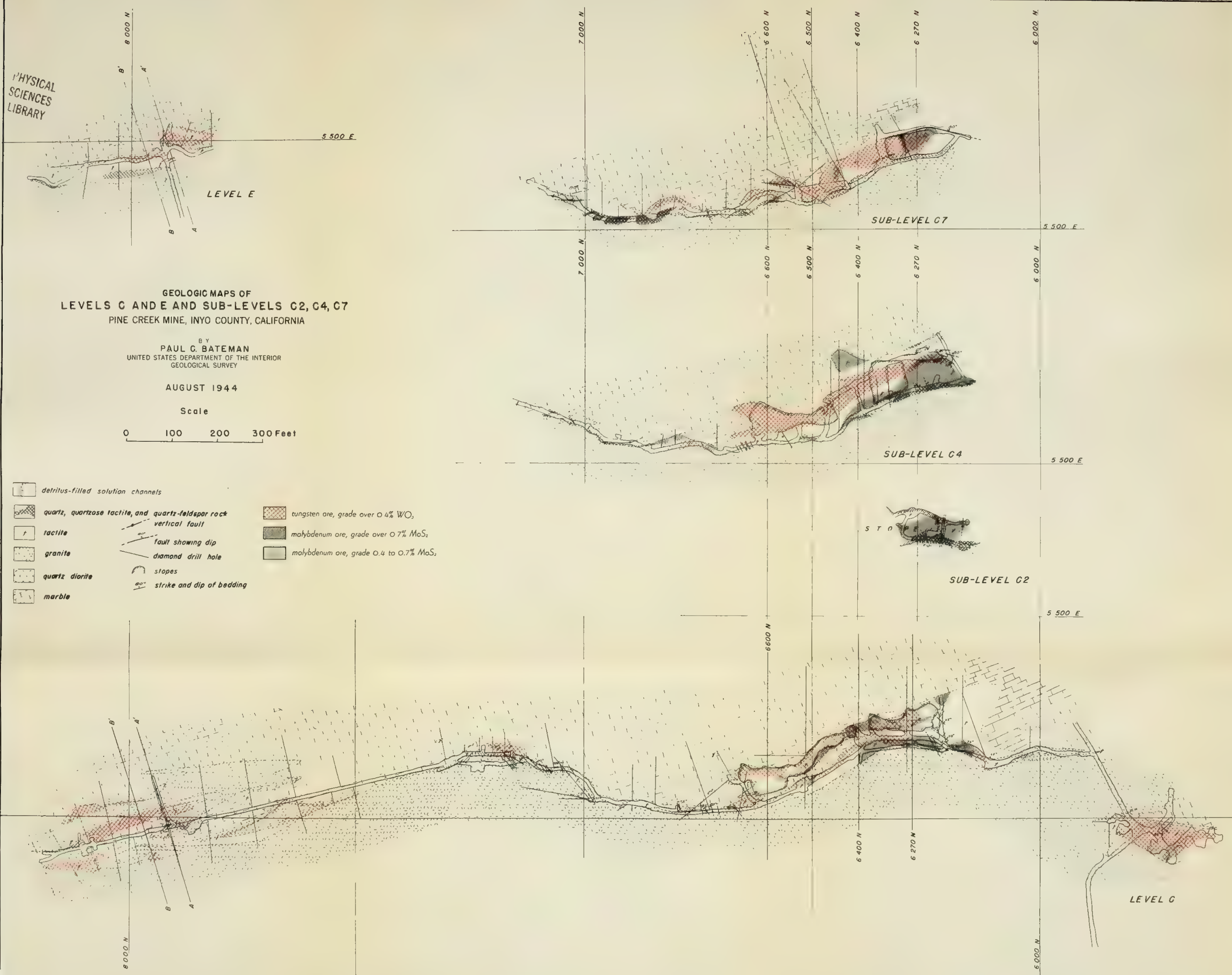


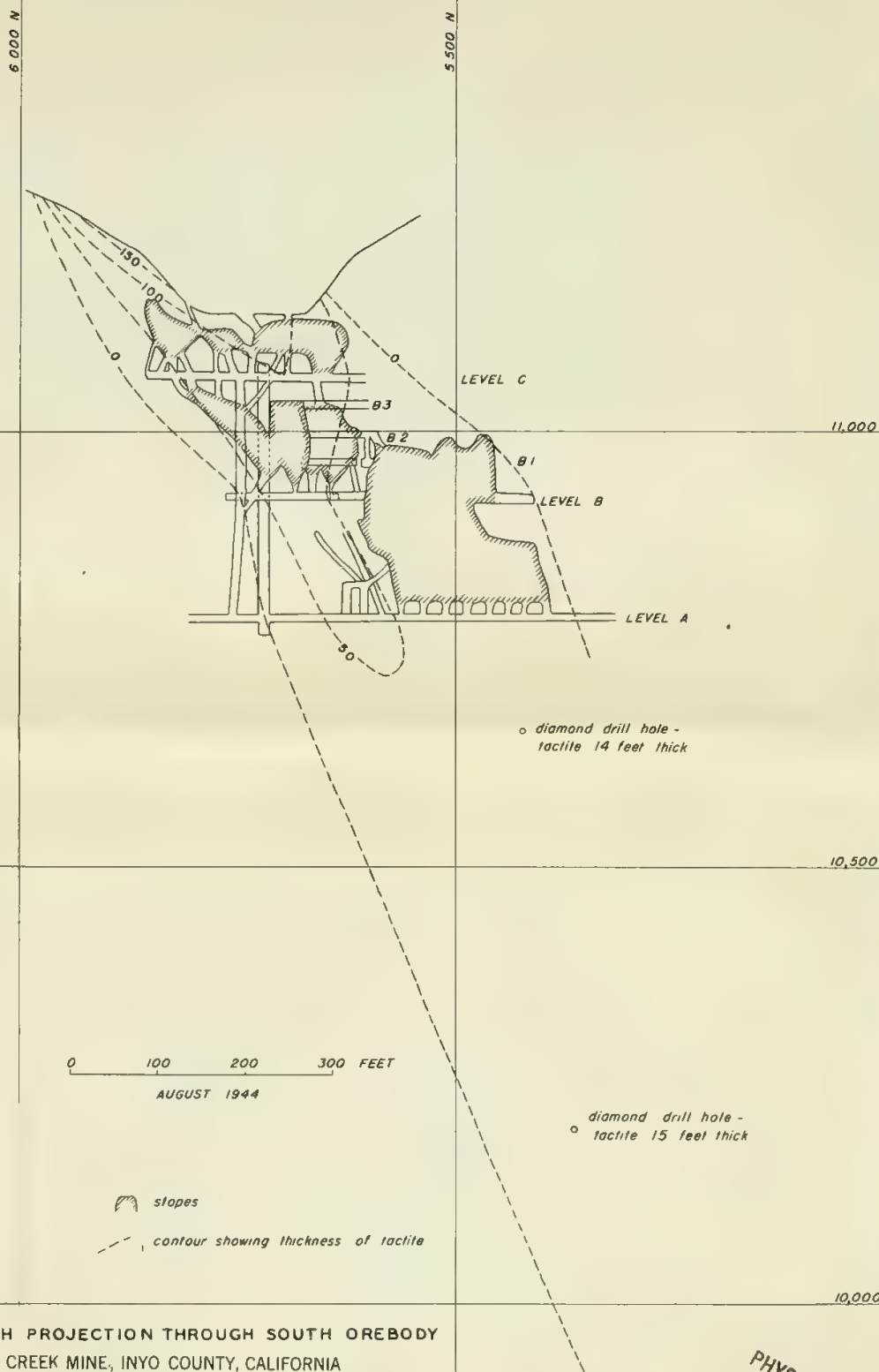
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GEOLOGIC MAPS OF
GRIZZLY, A1, A2, A3, A4, AND A5, SUB-LEVELS
PINE CREEK MINE, INYO COUNTY, CALIFORNIA

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NORTH-SOUTH PROJECTION THROUGH SOUTH OREBODY
PINE CREEK MINE, INYO COUNTY, CALIFORNIA

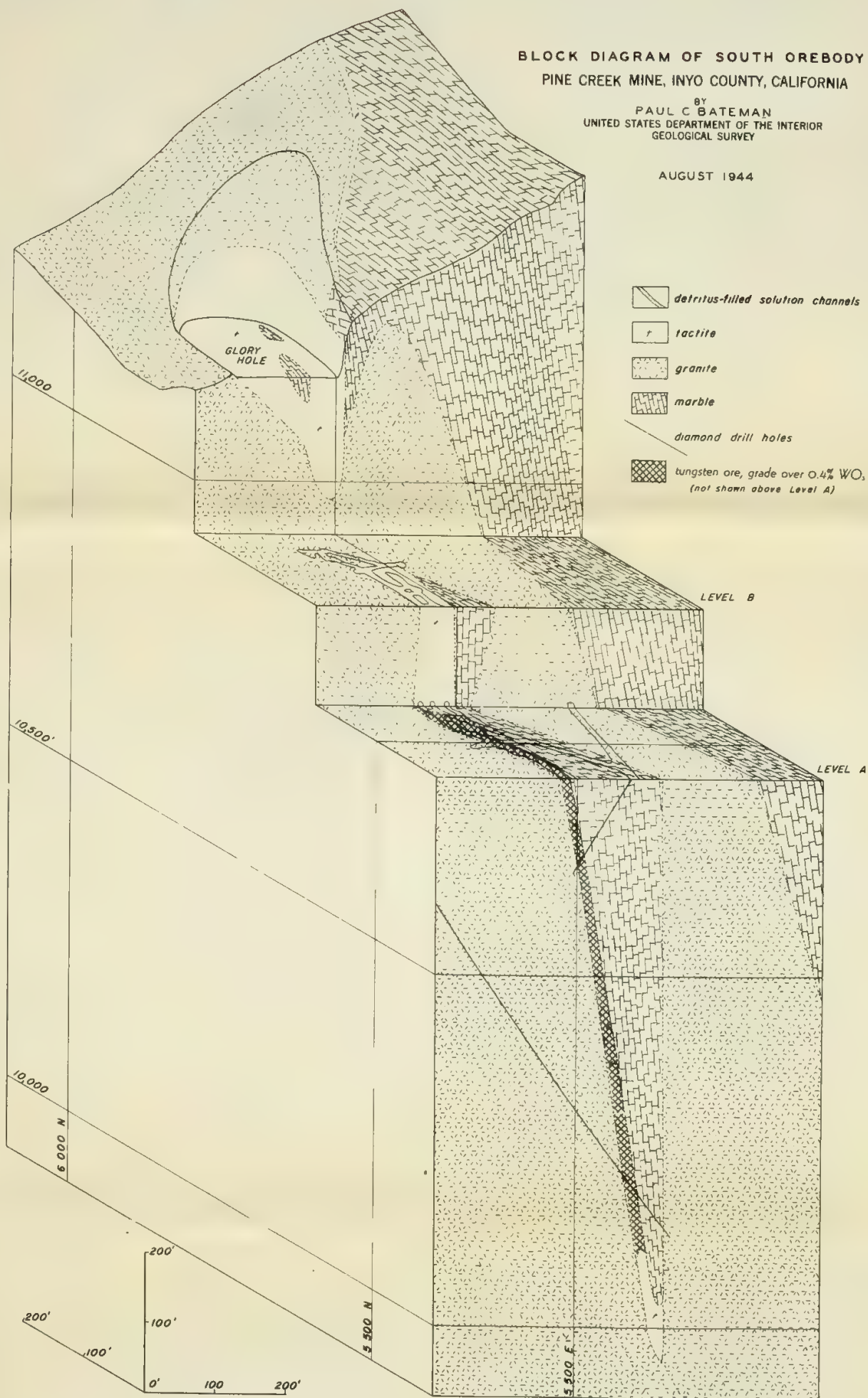
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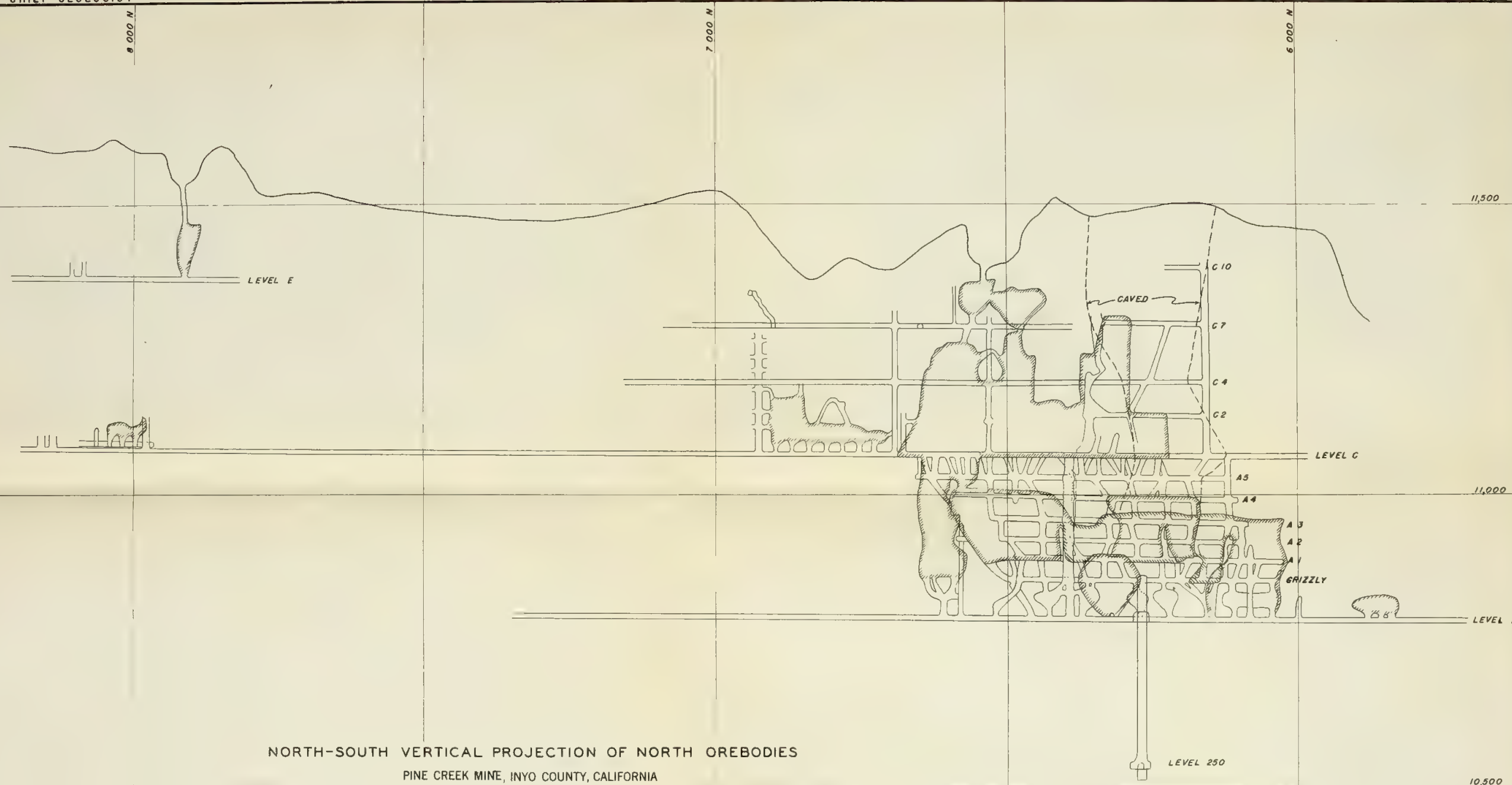
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BLOCK DIAGRAM OF SOUTH OREBODY
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NORTH-SOUTH VERTICAL PROJECTION OF NORTH OREBODIES
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SCALE

0 100 200 300 FEET

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west stopes
— outlines of west stopes

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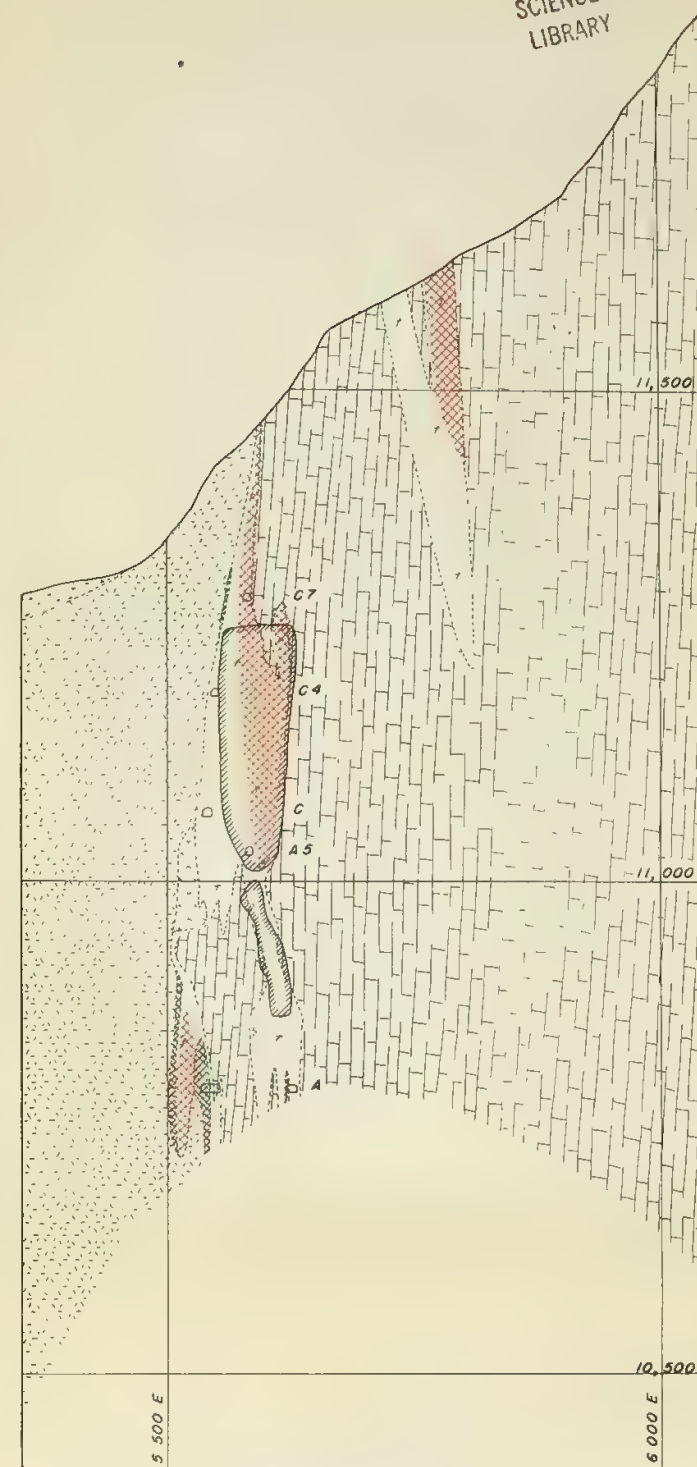
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SECTION 6270



SECTION 6400



SECTION 6600

GEOLOGIC SECTIONS THROUGH THE NORTH OREBODY
PINE CREEK MINE INYO COUNTY, CALIFORNIA

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AUGUST 1944

SCALE

0 100 200 300 FEET

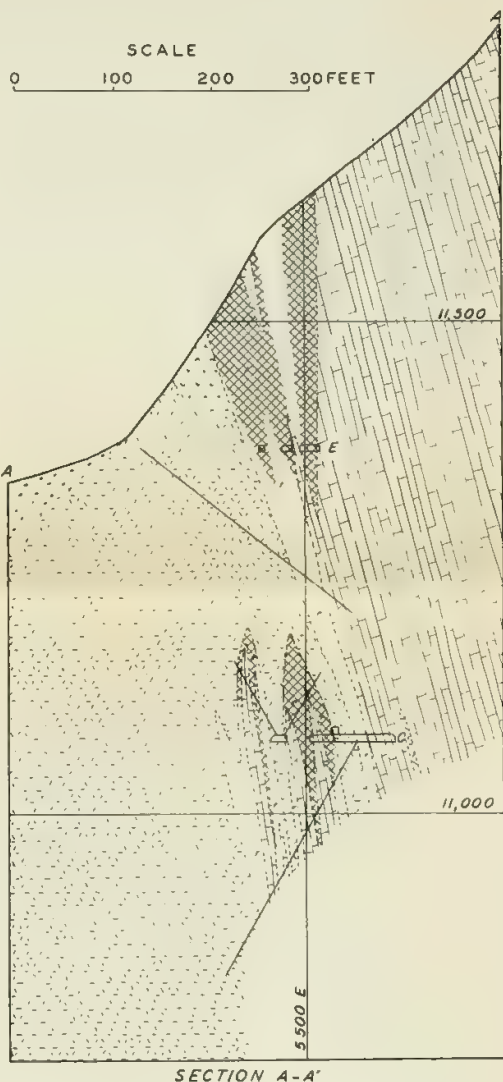
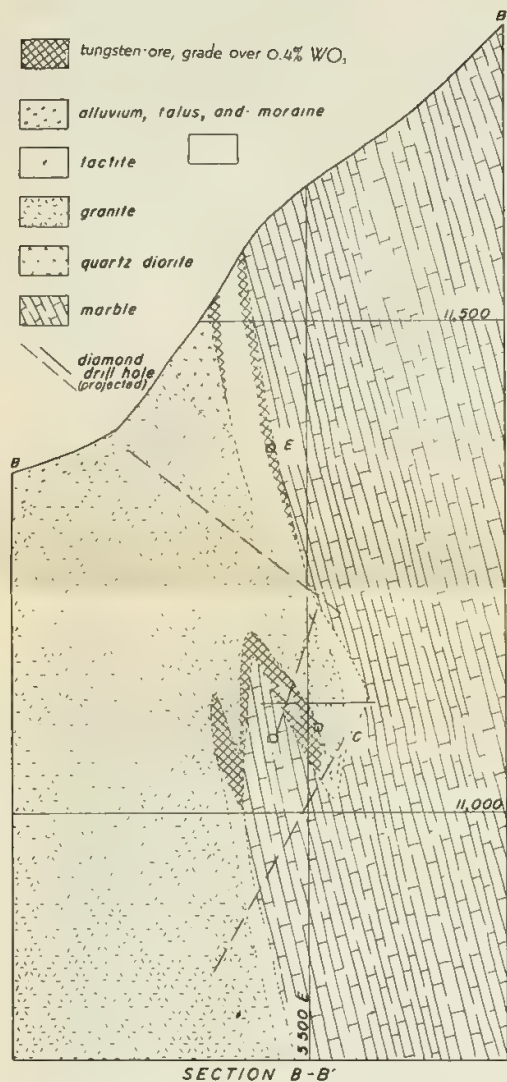
- alluvium, moraine, and talus
- detritus-filled solution channels
- quartz, quartz-feldspar rock, and quartzose facite
- tactite
- granite
- diorite
- marble
- slopes, except west slope
- west slope
- tungsten ore, grade over 0.4% WO_3
- molybdenum ore, grade over 0.7% MoS_2
- molybdenum ore, grade 0.4 to 0.7% MoS_2
- diamond drill hole

GEOLOGIC SECTIONS THROUGH LEVEL E OREBODY PINE CREEK MINE, INYO COUNTY, CALIFORNIA

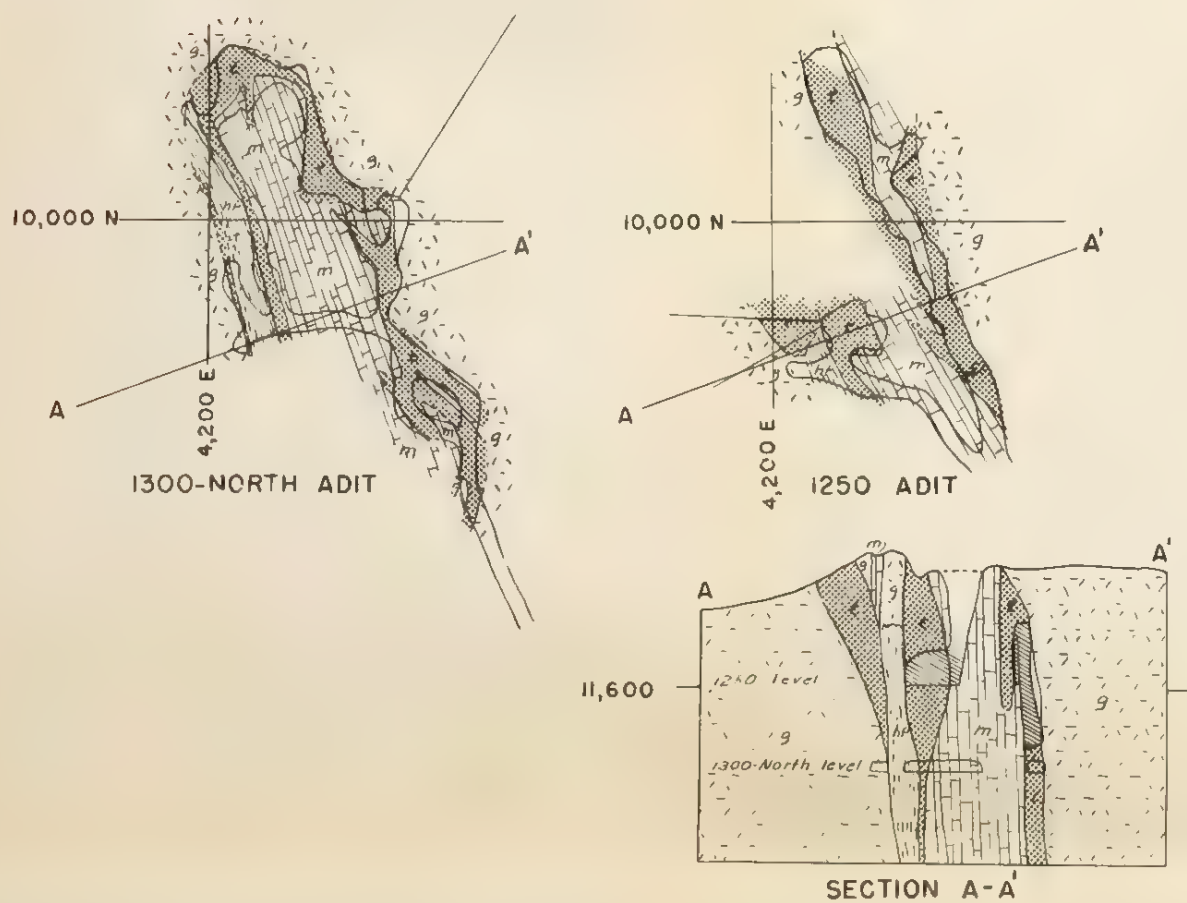
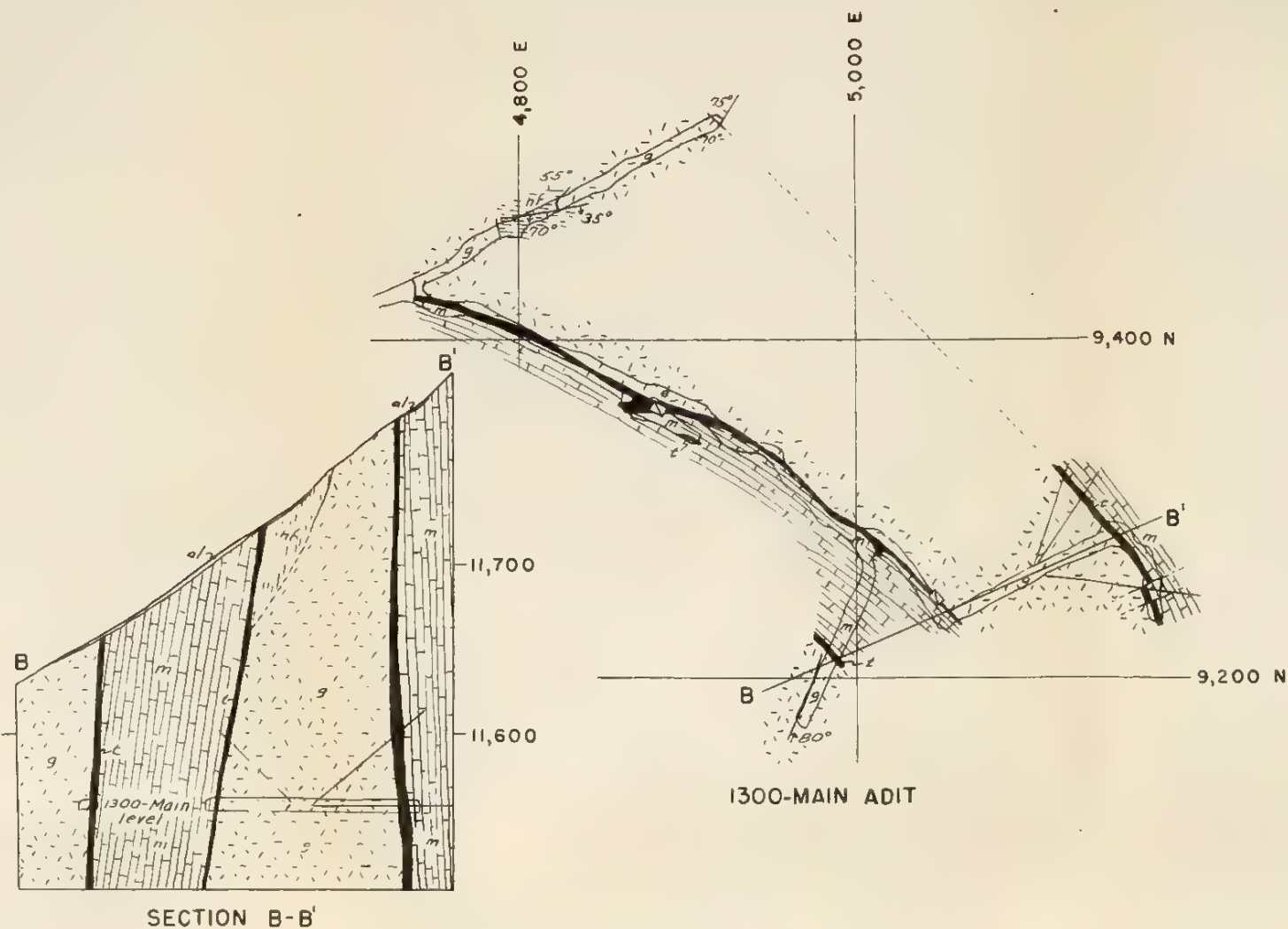
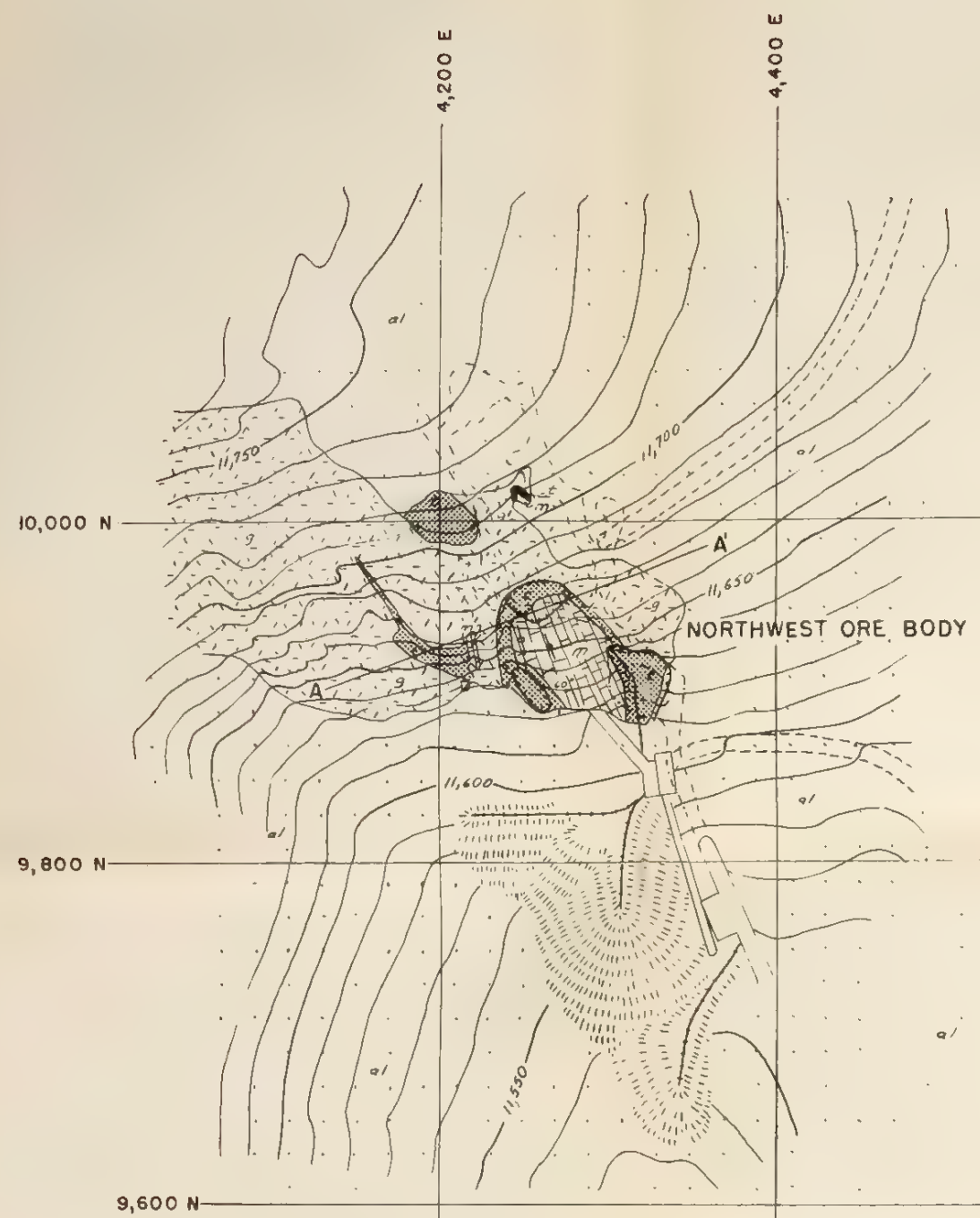
BY
PAUL C. BATEMAN

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY

AUGUST 1944

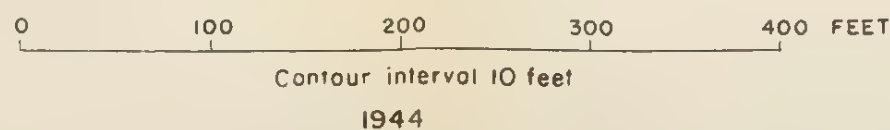


SCALE
0 100 200 300 FEET



- EXPLANATION
- Talus and glacial till
 - Tactite
 - Granite
 - Marble
 - Hornfels
 - Geological contacts, dashed where inferred
 - Faults, dashed where inferred
 - Strike and dip of bedding or contacts
 - Vertical bedding
 - Diamond drill hole, dashed if projected
 - Slopes, shown only in sections

MAPS AND GEOLOGIC SECTIONS
ADAMSON MINE, LOWER WORKINGS



UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Geology by P. C. Balemon and M. P. Erickson

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